UNSW
THE UNIVERSITY OF NEW SOUTH WALES

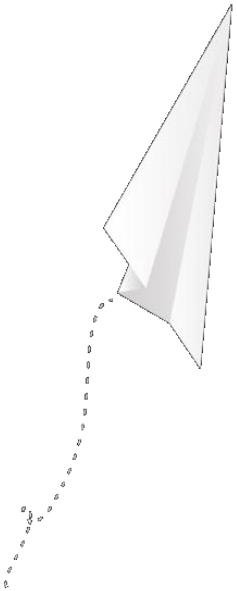
Postgraduate Research Competition for Excellence in Postgraduate Research Abstract Book 2011

Never Stand Still

Faculty of Science

program compilation by christina chung, faculty of science, UNSW | organisation of event by claudio sissa, faculty of science, UNSW |
www.science.unsw.edu.au |printing by Print Post Plus | cricos provider: 00098G

FACULTY OF SCIENCE
POSTGRADUATE RESEARCHCOMPETITION 2011



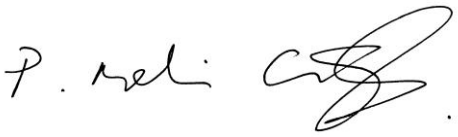
>>welcome

It is my pleasure to welcome all participants and supporters to the Faculty of Science Postgraduate Research Competition. This event has been organised to recognise the outstanding research our postgraduate students undertake. The event includes a poster presentation plus a speedy 1 minute 'taster' of the work along with an Abstract which you will see in this program.

The Faculty recognises that the work of its research students is a fundamental part of the high standing of the Faculty's research. I encourage you to look at the posters, listen to the presentations and discover the research that is conducted in the Faculty of Science. Please also interact with the students and enjoy the enthusiasm which they show for their work.

I would also particularly encourage current students who are planning research study, be it Honours, a PhD or a Research Masters, to talk with the entrants about their work and experiences.

Afterwards, I am sure you will agree with me that we are fortunate to be working with these future leaders of science and technology in academia, industry and the broader community.



Professor Merlin Crossley

Dean
Faculty of Science

foreward

The Faculty Postgraduate Research Competition, now in its second year, was created to recognise the importance of communication of scientific research to the broader community and also to showcase the amazing breadth of new ideas and creations across Science at the University of New South Wales, in particular, undertaken by postgraduate researchers.

The competition is open to all postgraduate researchers in the Faculty who have completed at least 1 year of their studies and less than 4 years. Researchers are asked to nominate whether they feel their presentation falls within one of 5 areas: Cutting-Edge Discovery Science; Energy and Materials Technologies; Climate, Environment and Sustainability; Living-Well and Ageing-Well and, Science and Society. There are 3 judging criteria. Firstly, entrants submit an abstract with their entry and from these abstracts a shortlist is developed to enter the competition. The abstract is also a part of the judging criteria. Researchers then create a poster, which is on display, and are asked to make a 1 minute presentation outlining their work. Presentations are grouped according to the applicant's nominated field. Judging is then undertaken by teams of senior researchers from within the Faculty of Science, the broader UNSW community and also a number of leading scientists from outside UNSW. We are particularly thankful to the judges for giving their time and consideration to the entrants.

Six prizes are then awarded to the best entrants, independently of the chosen field. There are 3 first prizes and 3 runners-up prizes, each with a significant monetary contribution to support travel to international conferences for the successful entrants. The 3 first prizes are also put forward as the Faculty's nominees for the UNSW 3 minute thesis competition.

We wish all competitors the very best in competition and also hope the audience finds the event exciting and informative.

Mark Hoffman

Associate Dean Research
Faculty of Science
UNSW

Gavan McNally

Associate Dean Research Training
Faculty of Science
UNSW

>>program

Thursday 4 August 2011
Leighton Hall, The John Niland Scientia Building
The University of New South Wales

2:00pm	Posters available for viewing
2:50pm	A/Prof. Gavan McNally, Associate Dean Research Training *Opening Remarks*
	1 minute presentations commence
3:00pm	Climate, Environment and Sustainability Cutting-edge Discovery Science
4:00pm	Energy and Materials Technologies Living well and ageing well
5:00pm	Science and Society
6:00pm	Judges confer
6:30pm	Presentation Ceremony commences Professor Mark Hoffman, Associate Dean Research *Opening Remarks*
	A/Prof. Gavan McNally, Associate Dean Research Training *Announcement of winners*
	Professor Merlin Crossley, Dean, Faculty of Science *Presentation of Awards*
7:30pm	Presentation Ceremony concludes

Light refreshments will be served from 6:00pm to 7:30pm

>contents


climate,
environment +
sustainability

PB & J: Pelagic-benthic coupling and the gelatinous pathway of carbon

Natasha Henschke and Iain Suthers
School of Biological, Earth & Environmental Sciences

Abstract

Large fast sinking particles such as carcasses have been suggested as important contributors of food to benthic communities, as they are less likely to be degraded upon arrival. In July 2007 and October 2009, mass depositions of the salp, Thetys vagina, were observed on the Tasman Sea floor off New Zealand and Australia. Video surveys and benthic samples were undertaken between depths of 200 to 2500 m to determine carcass density, distribution and biochemical composition. T. vagina carcasses dominated the benthic community, with a mean density of 37.58 ± 69.05 individuals 1000 m-2. Lipids were the main component of salp tissue, constituting 10.5 % of dry weight. Stable isotope analysis identified that salps were consuming differing phytoplankton species in both stations. The average standing stock of organic carbon associated with the carcasses was 1.13 mg C m-2 off New Zealand, and 14.46 mg C m-2 off Australia. Benthic crustaceans were observed directly feeding off carcasses, and high proportions of fish in the area have been identified to feed mainly on salps. This study suggests that although previously believed to be trophic "dead ends", salp carcasses provide both a highly nutritious contribution to the benthic food web and also further impetus for a gelatinous pathway of carbon.

Getting to the Guts of Seals

Tiffanie Nelson, Mark Brown and Tracey Rogers
School of Biological, Earth & Environmental Sciences

Abstract

Ninety percent of the cells making up our bodies are bacterial. Trillions of them reside in our intestines or guts, acting like an organ, providing us with health and nourishment. Yet, unlike other organs, we are born without bacteria and through life we collect a community of ~400 species. Getting the combination wrong, in the case of the gut community of an obese person, for example, means a 30% increase in energy or fat being stored in the body, regardless of the diet. In wild mammals living in cold, harsh places like the Polar Regions, the wrong combination could mean life or death, so how is the 'right' community selected? In my research, I've discovered that the gut bacteria of the southern elephant and leopard seals inhabiting the Antarctic have a core community of shared bacteria. When we compare these Antarctic seal "cousins" with their Arctic "second cousins", the grey, harbour and hooded seals, this core community is also present. Even though Antarctic and Arctic seals live at polar ends of the globe, and have been geographically separated for millions of years, they share the bacteria in their guts. So, when it comes to seal guts, choosing the 'right' community members is written in the genes of the seal, which selects for those members which will provide them with health and nourishment for living in their wild environment.

Reinterpretation of Megatsunami Inundation in Southeast Australia and the Implications for Palaeotsunami Identification

Claire Courtney, Dale Dominey-Howes, James Goff and Catherine Chague-Goff
School of Biological, Earth & Environmental Sciences

Abstract

The 2004 Indian Ocean tsunami resulted in a marked increase in concern regarding regions previously considered low risk of tsunami inundation. The southeast coast of Australia has a record suggesting low tsunami risk, with only 47 small tsunamis striking since European arrival. However, the controversial megatsunami hypothesis suggests patterns of massive inundation of the east Australian coast. Given the extreme vulnerability of the NSW coastline due to population concentration and the reliance on boulder deposit evidence, there is a need to provide thorough re-evaluation of the Australian tsunami risk.

This re-examination has led to research at four back-beach locations on the south coast of New South Wales, located close to sites reported to contain evidence of megatsunami inundation. Analysis of stratigraphy, sediments, geochemistry and microfossils, plus an extensive radiocarbon chronology of these sites allows for a full reconstruction of the Holocene environments. This success highlights the importance of using multi-proxy diagnostic techniques in investigating potential tsunami inundation sites with relatively short historical records. In the case of NSW, no evidence of Holocene tsunamis has been identified, casting serious doubt on the existing understanding of tsunami risk on the NSW coast and the diagnostic criteria used for identifying tsunami deposits.

Do animals on the ground really need trees?

Alan Kwok and David Eldridge
School of Biological, Earth & Environmental Sciences

Abstract

Mallee woodlands are an important ecological community in semi-arid eastern Australia, whose distribution has been substantially reduced since European settlement. Within mallee communities, substantial leaf litter accumulates around the trees, while the areas between the trees are virtually litter–free. Consequently the community is dominated by two major patch types; deep dense litter and bare soil. My research focuses on arthropod (insects, spiders, slaters) use of these two patches, and indicates that leaf litter is a crucial component of these mallee ecosystems, structuring fine- and broad-scale biodiversity. In areas not burnt by fire for several decades, leaf litter is abundant under the tree canopy and supports a different composition of arthropods such as slaters and jumping spiders, compared to areas devoid of leaf litter. In contrast, in recently burnt communities, the area under the tree canopy has considerably less leaf litter and therefore there are fewer differences between canopy and open areas. Furthermore, slaters are virtually absent in recently burnt communities. My research illustrates that patterns of arthropod biodiversity in mallee woodlands are dependent upon environmental characteristics that vary over tens of metres (leaf litter), and that this is intrinsically tied to broad-scale ecological processes such as fire.

Anatomy of a Warm-Core Eddy

Helen Macdonald and Moninya Roughan
School of Mathematics & Statistics

Abstract

Nutrients are essential for oceanic life. Nutrients provide food for the base of the oceanic ecosystem and can be sourced from water run-off from the adjacent continent or uplifted from the deep ocean to the light-penetrable surface layer.

Australia, with its minimal rainfall, has limited nutrients available through water run-off. Consequently, oceanic ecosystems off New South Wales (NSW) rely heavily on upward movement of water to bring nutrients from the dark interior of the ocean to the photosynthetically active surface layer.

Warm-Core Eddies (WCE) off NSW are large (hundreds of km in diameter) anticlockwise rotating bodies that push water downwards (away from the light). Subsequently, they are thought of as biologically unproductive.

The presentation focuses on output from a hydrodynamic model (ROMS) of a flooding event when this traditional idea of a WCE breaks down.

In this flooding event, water from the East Australian Current enters the top of the WCE, creating two distinct vertical layers. This can trap water near the surface where light is available for photosynthesis. Water from the lower layer is pushed out of the eddy and up towards the surface (and the light). This presentation also demonstrates how temperature gradients can drive this flooding event.

Won't someone please think of the children?! The missing link in understanding environmental impacts on fish communities

Andrew McKinley and Emma Johnston
School of Biological, Earth & Environmental Sciences

Abstract

Fish are the world's most economically and culturally important group of wild animals. As a result, a great deal of effort is focused on understanding how human actions impact fish communities. Unfortunately, monitoring and research has focused almost exclusively on adult fishes and only a handful of studies worldwide have examined impacts on early life stages. Just as our own children are more sensitive to physical stress than adults, it is at the earliest life stages that fish are most likely to be impacted by forms of disturbance such as pollution. I have conducted one of the first studies in the world to examine the impacts of pollution and habitat modification on wild marine fish larvae. My results demonstrate that stressors such as pollution and seagrass loss are likely causing major impacts on the composition, abundance, and diversity of larval communities. Some species are almost completely excluded by these stressors, while others truly flourish in highly contaminated environments. These impacts are of a much greater scale than what I have documented in parallel studies of adult fish. Impacts of this nature are almost entirely unmonitored and undocumented, but are likely to have far reaching ecological significance.

Weak jaws linked to extinction in Tassie tiger

Marie Attard, Steve Wroe and Tracey Rogers
School of Biological, Earth & Environmental Sciences

Abstract

With rapidly increasing rates of contemporary extinctions, predicting extinction vulnerability has become a key challenge in ecology. Understanding risk factors associated with extinction, such as diet, may assist future conservation efforts. Australia's iconic species, the thylacine, or commonly known as the Tassie tiger was a large carnivore and the only marsupial to become extinct in Tasmania following European settlement. The factors involved in its extinction have been argued, yet the underlying cause of their decline remains incomplete. Using advanced computer modelling techniques, we simulated various predatory behaviours to see patterns of stress in the skull. Simulations of thylacine skull performance were compared to living marsupial carnivores capable of catching large animals. Our findings suggest that the thylacine's jaws were too weak to capture and kill large prey. Rather, their exceptionally long snout was better suited to snapping up smaller, more agile prey. Specialising in small prey may have short-term success but is a long-term risk; as they are among the first to become extinct when the ecosystem becomes destabilised. With this inherent vulnerability, thylacines may have simply been unable to cope with environmental disturbances such as intensive hunting and habitat degradation following European arrival.

Impact of Micro-fabricated Surfaces and Protozoan Grazing on Marine Microbial Biofilms

Min Hui Low, Staffan Kjelleberg and Diane McDougald
School of Biotechnology & Biomolecular Sciences

Abstract

The impact of protozoan grazing on microbial biofilms developed on micro-fabricated poly-dimethyl siloxane (PDMS) surfaces was assessed after 20 days of exposure in the marine environment. Four different PDMS surfaces were used; 1, 2, 4 and 10 µm parallel grooves with equal widths and heights for the 4 and 10 µm fabrications, and equal widths but 0.5 µm in height for the 1 and 2 µm surfaces. At a depth of 2 meters in waters off the Sydney coast, biofilms were pre-established on the different micro-fabricated surfaces within environmental diffusion chambers for 15 days in the absence of large protozoans, then challenged with the surface feeding flagellate, Rhynchomonas nasuta for 5 days before sampling. 3D-images of biofilms were scanned using confocal laser scanning microscope (CLSM) and biomass quantified by IMARISTM software. Extracted DNA from the microbial community was analysed by 16S- terminal-restriction length polymorphism (T-RFLP) to investigate community composition differences on surfaces with and without of R. nasuta. Based on MDS and biovolume difference, R. nasuta grazing played a more crucial role in changing community compositions compared to micro-fabricated surfaces but biovolume differences on micro-fabricated surfaces is little between the presence and absence of R nasuta.

Toxicity conferring microbial communities: explaining the distribution of neurotoxin in sea-slugs

Rocky Chau and Brett Neilan
School of Biotechnology & Biomolecular Sciences

Abstract

Puffer fish (Fugu), blue-ringed octopus (Hapalochalaena), harlequin tree-frogs (Atelopus) and sea-slugs (Pleurobranchaea) are among 35 different species of organisms which produce the highly potent neurotoxin, tetrodotoxin. The wide distribution of tetrodotoxin across the animal kingdom is unusual and as yet, there is no explanation for this. Hypotheses have suggested that symbiotic bacteria are the true producers of these toxins. However, whether these bacteria are vertically transmitted (e.g. via progeny) or are horizontally transmitted (e.g. via diet) is unknown. Advances in DNA sequencing technologies have allowed us to compare the microbial habitats within different life-stages of both toxic and non-toxic Pleurobranchaea sea-slugs. The microbial habitats of captive, toxic sea-slugs were also investigated.

My research shows that different sea-slug types correlate with distinct microbial communities, with the exception of wild, toxic sea-slugs which have more variable communities. The microbial communities of both toxic and non-toxic Pleurobranchaea eggs do not show similarities to their adult counterparts, indicating that toxic microbial symbionts may not be transmitted vertically, but are acquired from the environment. Furthermore, toxic sea-slugs which have been raised in captivity have microbial communities more similar to wild, non-toxic slugs than to wild, toxic slugs, demonstrating that selective pressures are responsible for the maintenance of a tetrodotoxin-producing microbial community.

The bilby and bettong: Australia's endangered native marsupials holds the key to restoring degraded habitats

Ivan Wong and Brett Neilan
School of Biotechnology & Biomolecular Sciences

Abstract

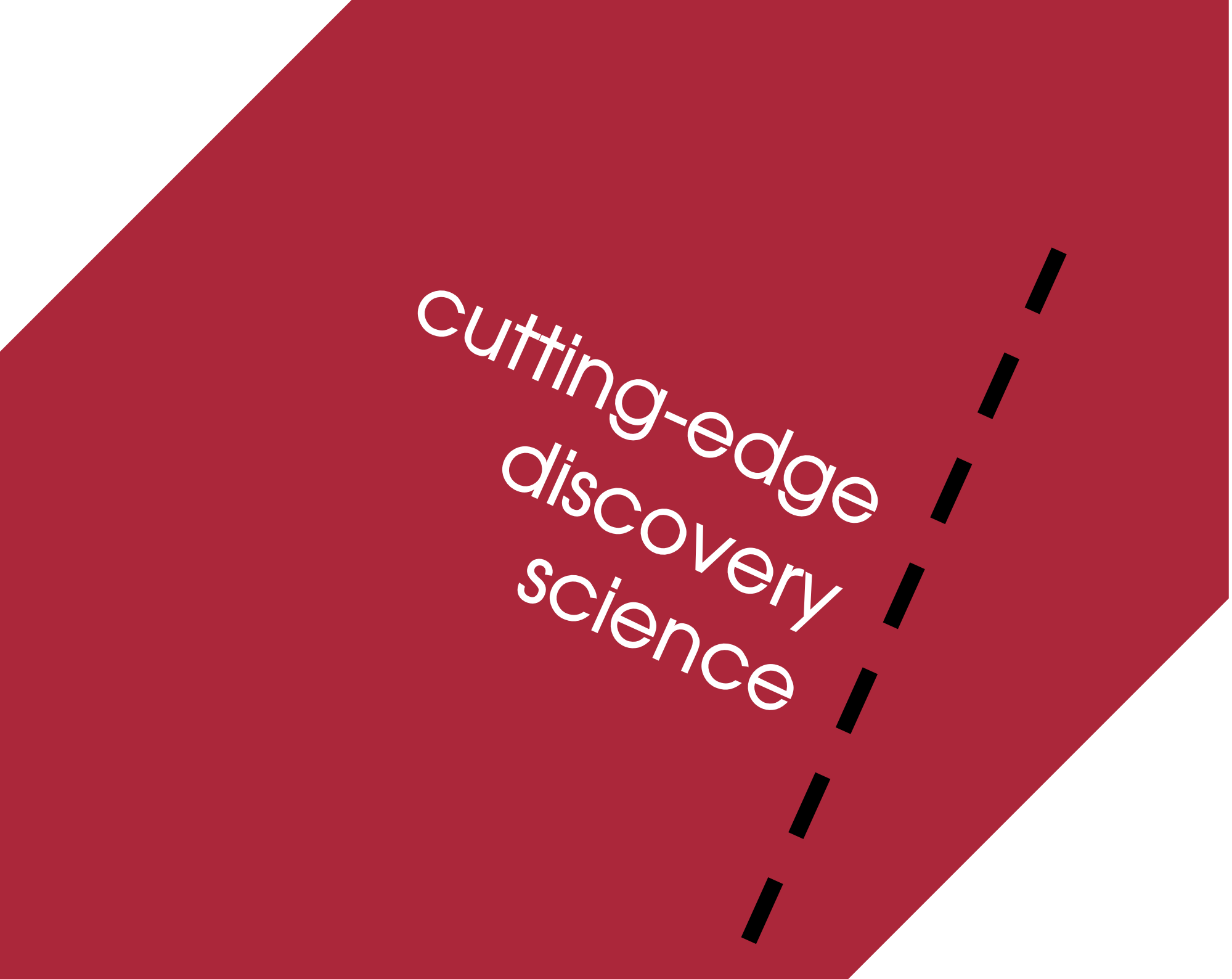
Arid Australia has suffered the highest rate of recently recorded mammal extinctions worldwide and has coincided with the deterioration of Australia's habitats. Our study site, Scotia Sanctuary (33°21′ S, 141°17′ E), has a predator proof fence and is home to the reintroduced Greater Bilby (Macrotis lagotis) and the Burrowing Bettong (Bettongia leuseur). Both the Greater Bilby and the Burrowing Bettong disturb the soil creating pits while foraging for food. Animal-created pits trap water, nutrients and organic matter with a potentially significant effect on ecosystem processes and improving soil health. The taxonomic and functional characterisation of resident pit microbiota (bacteria, eukarya and archaea) is a critical step in understanding the mechanisms by which animals and their pits influence soil ecosystem processes. To overcome the unrepresentative nature of traditional microbiology methods, we utilised next-generation sequencing technologies to assess both the taxonomy and functional potential of microbial populations inhabiting pits from native and non-native species. Through ribosomal tag pyrosequencing methods, shifts in pit microbial community structures are assessed. The composition of pit resident microbiota is a critical determinant of soil functionality which is influenced by animal species, proving a link between macro-fauna composition and the maintenance of ecosystem services.

The origin and variability of cold water events observed off Sydney, NSW

Julie Wood and Moninya Roughan
School of Mathematics & Statistics

Abstract

Physical processes such as intrusions of the East Australia Current (EAC), it's eddies and wind stress influence the continental shelf off Sydney, NSW. These processes can force isotherms to uplift leading to observations of lower temperature for a period of time. Water column temperature data from a near shore mooring off Bondi, Sydney, collected between May 2006 and June 2010 show, that while a seasonal cycle in temperature is observed, there can be large fluctuation from the average for a particular month. These anomalies occur more often in summer (where there can be dramatic shifts in the temperature) than in winter. Some of these anomalies in temperature may be attributed to cold water events driven by the presence of offshore eddies and/or the influence of the wind. Using high passed filtered, near surface temperature data, we have identified ten such events between August 2006 and April 2010 where cold water anomalies have occurred. Using current data from the mooring, wind data from an onshore site at Kurnell, Sydney and satellite sea surface temperature and current data, we visually assessed each event to determine the dominate forcing mechanism; either an eddy/EAC intrusion and/or wind stress. Seven events were caused by the EAC or its eddies, two by upwelling favourable wind and one by a combination of the wind and an eddy. The events were of varying duration from 1 day up to 12 days and both warm core and cold core eddy were able to force cold water events. Results for six of the events found between August 2008 and April 2010 were augmented with data from two additional moorings (NSW IMOS) in an array with the original mooring. Results show that each event is unique and depend on the strength and duration of the forcing mechanism and, in the case of eddies, the proximity to the coast.


cutting-edge
discovery
science

Disentangling an entangled bank

Raymond Blick and Angela Moles
School of Biological, Earth & Environmental Sciences

Abstract

The world we live in is inherently connected. But in a world with so many connections how do we disentangle any discernible structure from what appears to be chaos? This line of thought has generated big ideas such as the 6 degrees of separation to Darwin's curiosity with a tangled mix of plants at Down House. However the question remains, how do we disentangle the complexities that exist in the natural world? One approach that has gained significant momentum is the use of network theory. Generating networks that portray multiple interactions has been applied to a range of disciplines including social networking, psychology, and ecology. My research focuses on network interactions between forest structure and arboreal plants. A variety of results have been revealed from this approach including (i) the level of antagonism between arboreal plants determines community structure, (ii) few host trees are responsible for maintaining significantly large populations of mistletoe's and (iii) similarities in leaf shape do not match network interactions, refuting the widely held view that mistletoe's mimic their hosts. The network approach provides a foundation for testing the biological processes underpinning community structure and a powerful approach to understanding a seemingly chaotic world.

Contemplating the Curves!

Vinod Maseedupally and Helen Swarbrick
School of Optometry & Vision Science

Abstract

Orthokeratology (OK) is a clinical contact lens-based technique in which specially designed rigid lenses reshape the cornea during overnight wear to temporarily correct refractive error after lens removal. During OK for myopia correction, the refractive outcome arises from lens-induced central corneal flattening and mid-peripheral steepening, which collectively result in reduced corneal power and a more spherical or oblate-shaped cornea. However the overall changes in corneal shape during OK are more complex, because normal corneal shape may vary from region to region. No previous studies have investigated differential effects of OK on different regions of the cornea.

In preliminary studies, we have investigated the regional effects of spherical OK lenses on spherical corneas. This study showed non-uniform changes in corneal curvature in different corneal regions. The curvature in the temporal sector of the central zone flattened significantly ($p<0.001$); while there was simultaneous significant steepening ($p<0.001$) of the nasal sector of the para-central zone, indicating temporal decentration of the lenses. Further investigations are planned to study the corneal changes occurring with spherical OK lenses on astigmatic (toric) corneas. Greater understanding of these regional changes will allow us to create new OK lens designs to correct non-spherical refractive errors such as astigmatism.

The application of high-throughput sequencing to determine the abundance of microbial bioactive small molecule biosynthesis pathways in diverse environments

Jason Woodhouse and Brett Neilan
School of Biotechnology & Biomolecular Sciences

Abstract

Since the discovery of penicillin, scientists have extensively cultured and screened millions of bacteria and fungi for compounds able to combat emerging diseases and drug resistant pathogens. These natural products exhibit seemingly limitless chemical diversity, with little known regarding their ecological significance. In the endless search for novel compounds, researchers are constantly searching for new environments from which to isolate producing organisms. Amongst these, marine sponges, medicinal herbs and microbial mats are each noted as being rich, unlimited sources of natural products. Accessing or even determining the diversity of these environments has traditionally involved arduous culture dependent processes. Here we demonstrate the use of cutting edge sequencing technology to assess the richness of environments associated with natural products by targeting genes responsible for the biosynthesis of two major classes of natural products. The richness of each environment was represented as a correlation between the sampling depth and the identification of unique biosynthesis genes. From the information obtained it is possible to elucidate, not only the total biosynthetic diversity, but also which organisms are the most dominant producers, allowing for the tailoring of methodologies for the isolation of the producers or culture-independent based production of the compounds.

A Novel Control Point in Cholesterol Synthesis

Julian Stevenson and Andrew Brown
School of Biotechnology & Biomolecular Sciences

Abstract

Cholesterol is essential, but in excess can lead to cardiovascular disease, Australia's number 1 killer. Cellular cholesterol levels are exquisitely controlled partially through regulation of its biosynthesis. Study has focused on 3-hydroxy-3-methyl-glutaryl-coenzyme A reductase (HMGR), billed as the rate-controlling enzyme in the pathway, and target of the blockbuster statin class of drugs. In contrast, remarkably little is known about the more than twenty other enzymes, which are thought to be unimportant for regulation compared to HMGR. Surprisingly, we observed that cholesterol treatment caused squalene to accumulate, indicating that squalene monooxygenase (SM) may serve as a rate-limiting enzyme after HMGR. This was also seen in mutant cells lacking sterol regulated transcription. Indeed, SM protein was degraded within hours of cholesterol addition. Proteasomal inhibition blocked this degradation and reversed the squalene accumulation, suggesting that the cholesterol-induced degradation of SM is a flux control mechanism, a new example of end-product feedback inhibition. This required the N-terminal domain, or beginning of SM, which also conferred cholesterol-regulated turnover on unrelated fusion proteins. Therefore, we have identified an important novel control point in cholesterol synthesis. This is a new target for the development of better drugs for the treatment of hypercholesterolemia.

A picture tells a thousand nerves

Edward Lum and Helen Swarbrick
School of Optometry & Vision Science

Abstract

Orthokeratology (OK) is a clinical technique that uses specially designed rigid contact lenses to reshape the corneal contour to temporarily correct refractive error. This study aimed to map the sub-basal nerve plexus (SBNP) in the cornea of an OK lens wearer.

Method: Laser scanning in vivo confocal microscopy was performed on two subjects: a non-lens wearer and medium-term OK lens wearer (9 years of wear). Scans were performed on the right eye while the left eye fixated a moving target. A total of 575 and 676 contiguous images of the SBNP were taken from the non-lens and OK lens wearing subjects respectively. These images were used to construct maps of the central to mid-peripheral SBNP.

Results: In the non-lens wearing eye, nerves radiated towards a whorl-like complex centred nasally and inferiorly. In the OK lens wearing eye, this whorl pattern was absent, replaced by a tortuous network of nerve fibres centrally, and thicker curvilinear fibres mid-peripherally, particularly in the nasal, inferior and temporal regions.

Conclusion: This is the first study to map the corneal SBNP in an OK lens wearer. It demonstrates that OK lens wear alters the normal SBNP distribution observed in healthy, non-lens wearing eyes.

Using viruses to break up bacterial infections

Janice Hui, Scott Rice and Staffan Kjelleberg
School of Biotechnology & Biomolecular Sciences

Abstract

Bacteria can also get sick because of viruses, called bacteriophages/phages. As with viruses on higher organisms, phages are host-specific and undergo two different life cycles. In the lytic stage, the host cell dies, while in the lysogenic stage the viral genome integrates with host DNA, establishes mutual symbioses conferring adaptation and survival benefits that are passed on to subsequent cell generations.

Pseudomonas aeruginosa strain PAO1 is a major pathogen infecting cystic fibrosis patients by forming prolific slimes, or biofilms. The Pf4 phage infects its host PAO1 during biofilm development when it converts from the lysogenic to lytic stage.

Bacteria suffer environmental stress and undergo adaptive mutation when biofilms become over-populated and nutrient-poor, switching on the phage lytic cycle and killing biofilm cells. I am investigating how to use phage in targeted control of biofilms and infections.

My research has identified a protein (repressor C) of PAO1 responsible for viral infection immunity. Mutations in this protein switch the Pf4 phage to its lytic stage, killing the host. Furthermore, large deletions of the Pf4 phage genome within PAO1 cause biofilm cell death.

We plan to use these findings to develop biofilm control treatments, especially for preventing chronic infections with cystic fibrosis patients.

Probing uncharted space between Earth and the distant Universe: Discovery of an 'invisible' star-forming galaxy

Anant Tanna and Steve Curran
School of Physics

Abstract

Employing the novel technique of using the world's largest steerable radio telescope to scan the entire redshift space towards quasars, the most distant objects in the Universe, we have discovered an extremely gas rich galaxy that is invisible to even the best optical instruments.

The galaxy is detected in absorption of the neutral hydrogen (HI) 21-cm electron spin-flip spectral line. This line traces the reservoirs of cool gas required for star formation, and thus for the formation of planets and ultimately of life.

Our 21-cm spectrum allows measurements of the galaxy's redshift and gas content. This may be the strongest hydrogen absorber ever found, not just in HI 21-cm but in total hydrogen. The redshift measurement allowed us to resolve a confusing feature known as 'Object X' seen amongst the gravitationally lensed images of the background quasar, having implications for current models of gravitational lensing.

This is the third absorber seen along the sight-line to the background quasar and resides at a look-back time of 4.1 billion years (the quasar lies at 11.1 billion years). This is the first ever detection of a third HI 21-cm absorber in a single sight-line and has profound implications for searches of the missing star forming material in the Universe, a science goal of the future SKA.

Bad bugs and dirty data: removing errors from microbial genome sequencing

Kerensa McElroy and Torsten Thomas
School of Biotechnology & Biomolecular Sciences

Abstract

Genome sequencing has been transformed by recent technological advances - in 2000, a single gene could be sequenced in a day; now, the genomes of an entire microbial community can be sequenced in as much time. Theoretically, this revolution allows us to watch 'evolution in action' - by sequencing evolving microbes throughout an infection, we can detect the small changes in DNA that let a bacteria survive antibiotics or a virus evade immune system attack. However, as sequencing has become faster, data quality has deteriorated, making it difficult to distinguish true mutations from sequencing errors. We can remove most random errors using Bayesian statistical techniques. Particular DNA 'words', however, are systematically error-prone. We solve this problem by observing that sequencing machines read DNA from right to left as well as left to right – a difficult DNA 'word' is often easy to read in reverse! A simple read-direction filter can thus remove systematic errors. Using sequencing data 'cleaned' with our methods, we have shown that Hepatitis C virus can evolve rapidly, acquiring new mutations that allow it to hide from the patient's immune system and become a life-threatening infection. So, even dirty data can catch a bad bug in the act!

A role for phosphatidic acid in the formation of "supersized" lipid droplets

Yuxi Zhang and Robert Yang
School of Biotechnology & Biomolecular Sciences

Abstract

Lipid droplets (LDs) are important cellular organelles that govern the storage and turnover of lipids. Little is known about how the size of LDs is controlled, although LDs of diverse sizes have been observed in different tissues and under different (patho)physiological conditions. Recent studies suggest that the size of LDs may influence adipogenesis, the rate of lipolysis and the oxidation of fatty acids. Here, a genome-wide screen identifies yeast mutants that give rise to "supersized" LDs that are up to 50 times the volume of LDs in wild type cells. Biochemical and genetic analyses reveal that a common feature of these mutants is an increase in phosphatidic acid (PA) levels. Results from in vivo and in vitro analyses suggest that PA may facilitate the coalescence of contacting LDs, resulting in the formation of "supersized" LDs. In summary, we here identify novel gene products that regulate phospholipid metabolism and provide insights into how the size of LDs is determined.

Lysine methylation: Identification & functional significance in Saccharomyces cerevisiae

Timothy Couttas and Marc Wilkins
School of Biotechnology & Biomolecular Sciences

Abstract

This study examined lysine methylation, a modification that the extent and significance in the cell is undetermined. Here we explore strategies to identify and explain the functional importance of methylation in Saccharomyces cerevisiae. Methyllysine identification was examined using a combinatorial hexapeptide ligand library to reduce the dynamic concentration range of proteins within S. cerevisiae. Enriched lysate was separated and analysed by LC-MS/MS for the presence of methylated lysine. The enrichment process identified 23 novel, high confidence methylated lysine residues. Hexapeptide enrichment identified methylated lysine residues with a 4 fold improvement when compared to untreated whole cell lysate.

Methylation of proteins occurs through specific enzymes called methyltransferases. The majority of methyltransferases responsible remain undetermined. Single gene knockouts of known and putative methyltransferases were examined in S. cerevisiae. Knockout-derived lysate was separated by 1D-SDS-PAGE, and immobilised onto PVDF membranes to enable detection of methylation with antibodies. Comparison between wild type and knockouts identified molecular weight band differences for methyltransferases Rkm1, Efm1 and See1. These enzymes are believed to be responsible for methylating proteins involved in translation. Methylation is known to be required for the interaction of many proteins. This phenomenon was explored by analysing S. cerevisiae complexes using blue native polyacrylamide gel electrophoresis (BN-PAGE). S. cerevisiae knockout strain ΔRkm1 showed an absence of 800kDa band. LC-MS/MS identified the band in the wild type strain as the 6-phosphofructokinase heterooctamer complex, which is known to have methylation on the beta subunit. This finding suggests methylation may be associated with protein complex formation.

Where are the biggest stars in our Galaxy found?

Vicki Lowe and Maria Cunningham
School of Physics

Abstract

Giant molecular clouds (GMCs) are the birthplace of the biggest stars in our Galaxy, the Milky Way. GMCs typically have masses of millions of Suns and span up to 200 light years. We are studying one GMC in the southern sky that likely exhibits the key stages of star formation from the earliest pre-stellar clumps to stars that have already reached the end of their lives in a supernova explosion. Previously, the entire GMC was surveyed for cold dust clumps - which are the earliest signatures of star formation. We have used the Tidbinbilla 70 metre radiotelescope, located near Canberra, to observe these cold clumps and determine their physical properties. To measure their physical properties, we use emission from the ammonia molecule, which has unique spectral line features, to directly determine the temperature of the cold clumps. We have found that the clumps generally have temperature in the range 15-40 K, showing some are unusually cold. This is a strong indicator that many clumps are still yet to form stars. In the future, we will determine the mass of the clumps to identify which will form the biggest stars.

Proteome-scale analysis of arginine methylation in Saccharomyces cerevisiae

Jason Low and Marc Wilkins
School of Biotechnology & Biomolecular Sciences

Abstract

Post-translational methylation of arginine has been recognised as a mechanism for regulating RNA-protein and protein-protein interactions. Dysregulation of arginine methylation has been linked to cardiovascular disease, muscular dystrophy and cancer in humans. Despite extensive research interest, in Saccharomyces cerevisiae, only 14 arginine-methylated proteins and 3 of their respective methyltransferases have been described. Currently, the project aims to understand the predominance and function of arginine methylation in the S. cerevisiae proteome. This will ultimately aid related investigations in higher order organisms.

An array consisting 4221 immobilised proteins on a microscope slide was analysed using antibodies conjugated to a fluorescent dye. Fluorescence levels were quantified and top-scoring proteins across replicate experiments were extracted for further analysis.

We identified a total of 348 potentially arginine-methylated proteins; 133 were of high confidence. Further analysis showed significant enrichment for proteins involved in RNA processing and ribosome biogenesis. This is consistent with, and substantially extends the functional association of this modification.

This is the first systematic large scale study on the extent of arginine methylation in the S. cerevisiae proteome. Our results support the idea that the methyl-proteome is indeed larger than currently evidenced. Future studies will focus on determining the precise function of arginine methylation.

Quantum Properties of Near-Black Hole Objects

Graeme Gossel and Victor Flambaum
School of Physics

Abstract

We present results of calculations involving bound and unbound scalar particles in the gravitational field of a central body that is near the threshold of being a black hole.

In the bound particle case we find that only in the limit that the body tends to the black hole case is an energy level with zero energy possible. As this is a necessary, but not sufficient, condition for Hawking radiation this implies that Hawking radiation is not possible around such non-singular static bodies. Given that 'pure' black holes require infinite time to form and these limiting cases do not permit Hawking radiation, does Hawking radiation exist in nature?

In the unbound particle case we find a new spectrum of dense and narrow resonances. These resonances represent long lived quasi-bound states of the particle. As the black hole limit is approached, the distribution of these states becomes denser and the delay times become larger. This dense spectrum of long lived states gives rise to effective absorption of the particle. Thus as the central body approaches the black hole threshold, so it smoothly acquires a black hole-like absorption spectrum; an object that is not yet a black hole may look like one.

Particle dynamics in an annular shear cell

Xing Wang and Aibing Yu
School of Materials Science & Engineering

Abstract

Mechanical and rheological properties of solid flow in an annular shear cell are investigated by a series of discrete particle simulations of slightly polydispersed spheres from quasi-static to intermediate regimes. The parametric study shows that the normal pressure, shear velocity, particle friction coefficient and rolling friction coefficient have noticeable influences on the microdynamic variables such as porosity and coordination number. The overall coordination number and density are found to collapse on a linear master curve, with an applicable coordination number between 5 and 6.5. The deviation from the relation may be related to the significant changes in the probability distribution of the scaled contact force. A linear relationship between the (internal/external) shear and normal stresses prevails in the shear cell and the internal and external friction coefficients can compare well with each other. The so-called I-rheology is rigorously tested in this cell system. Our results unambiguously display that the I-rheology can effectively describe the intermediate flow regime, with an empirical fit obtained for the present annular shear cell system. However, significant deviations take place when it is applied to the quasi-static regime which corresponds to very small values of inertial number.

Nanoparticles of semi -conducting materials targeted toward bio-labelling

Fatemeh Mir Najafi Zadeh and John Stride
School of Chemistry

Abstract

Quantum dots (QDs) are a special class of nano particles having unique optical properties (1, 2). They are very good candidate materials for medical imaging, assisting in the detection of cancer as markers and in the active delivery of chemotherapy drugs to cancer cells (3). In order to apply QDs to biological systems, they should be both water soluble and bio-compatible (4). The aims of the project involve investigating the synthesis and application of QDs in a biological context by reducing the toxicity of QDs and creating something which could, in theory, be injected into the body for diagnostic purposes. According to the aims of the project, cubic CdSe cubic QDs have been synthesized in an aqueous route at low temperature and under less harsh chemical condition than otherwise used. They characterized by X-ray powder diffraction (XRD), transmission electron microscopy (TEM), UV-visible absorption and laser emission spectroscopy. By the end of project, a range of biocompatible QDs with a range of analytical functions will have been developed.

References

(1) Zhao, M.-X.; Xia, Q.; Feng, X.-D.; Zhu, X.-H.; Mao, Z.-W.; Ji, L.-N.; Wang, K. Biomaterials 2010, 31, 4401.

(2) Singh, S.; Bozhilov, K.; Mulchandani, A.; Myung, N.; Chen, W. Chemical Communications 2010, 46, 1473.

(3) Wu, Z.; Zhao, Y.; Qiu, F.; Li, Y.; Wang, S.; Yang, B.; Chen, L.; Sun, J.; Wang, J. Colloids and Surfaces A: Physicochemical and Engineering Aspects 2009, 350, 121.

(4) Gao, Y.; Zhang, Q.; Gao, Q.; Tian, Y.; Zhou, W.; Zheng, L.; Zhang, S. Materials Chemistry and Physics 2009, 115, 72.

Total Synthesis and SAR development of potent anticancer natural product Urukthapelstatin A

Seong Jong Kim and Shelli R. McAlpin
School of Chemistry

Abstract

Urukthapelstatin A, containing five-membered heterocyclic subunits, such as oxazoles and thiazoles has diverse significant biological activities including anti-tumor. Herein is described the first total synthesis of the natural product Urukthapelstatin A based on a combination of peptide and heterocyclic synthesis via general routine pathways like using DAST/cyclization and Bromo-chloroform oxidation methodology to form oxazoles, and the Hantzsch reaction to form thiazoles. Lastly, this modular nature of the synthesis can also accommodate modifications for SAR studies and biological activities of the synthesized analogs.

Using hole transitions in highly charged ions as a test for varying fundamental constants

Andrew Ong, Victor Flambaum and Julian Berengut
School of Physics

Abstract

The ongoing search for a cosmological variation of fundamental constants has prompted independent laboratory corroboration of what might be one of the most counter-intuitive theories yet - that the fundamental constants that govern our universe actually vary, itself an important and necessary for grand unifying theories of nature to be formulated.

Cosmological searches have focused on the spatial variation of these constants, therefore if such is true then since our solar system is moving through a region of changing constants, in time we should be able to detect this variation using clocks in laboratories as well. Atomic clocks are the most precise clocks available, and we have discovered that using hole transitions in highly charged ions as a basis for atomic clocks, combined with specific level crossings, a factor of 13 improvement in sensitivity can be yielded over the best current experimental results. We believe that this level of precision will most likely be sufficient in detecting a spatial variation of fundamental constants in a laboratory conclusively.

Adaptation improves neural coding efficiency despite increasing correlations in variability

Mehdi Adibi and Ehsan Arabzadeh
School of Psychology

Abstract

Prolonged exposure of cortical neurons to sensory stimuli results in a change in their response function. This phenomenon, known as sensory adaptation, is a common feature across sensory modalities. Here, we characterise adaptation in rat whisker system. This is an ideal model system because of its functional efficiency and its well-studied anatomical organisation. Every whisker is represented by a cluster of neurons in S1, called a barrel. Barrels preserve the arrangement of whiskers on the snout. Using an electrode array, we extracellularly recorded the activity of barrel cortex neurons in anaesthetised rats and characterised the response of neurons in 3 states of adaptation. The stimuli comprised of vibrations ranging 0-33μm while the adapters had magnitudes of 0, 6μm or 12μm. The neuronal responses, as a function of test stimulus amplitude, were well-fit by a sigmoid curve. Simultaneous recordings from multiple neurons (5-25 units) in one session allowed us to quantify the trial-by-trial correlations across neurons (in the form of signal- and noise-correlations). The noise correlation was in the direction of the signal correlation which led to a decreased discriminability of the population by as much as 14% compared to an independent population. The adapters produced a systematic lateral shift in the population response function. The magnitude of the rightward shift was proportional to the amplitude of the adapter. Receiver operating characteristics (ROC) and information theoretic analyses revealed that adaptation enhances the discrimination performances most prominently at amplitudes greater than the adapter.

Synthesis of Sansalvamide A Peptidomimetic Derivatives

Hendra Wahyudi and Shelli R. McAlpine
School of Chemistry

Abstract

The marine natural product Sansalvamide A (San A) is a macrocyclic pentapeptide that possesses anti-cancer activity against a number of cancer cell lines. San A derivatives are particularly effective against pancreatic cancer cell line PL-45 and drug-resistant colon cancer cell line HCT-116. Through mechanism of action studies, we have determined that San A acts, at least in part, by binding to Heat Shock Protein 90 (Hsp90) and inducing programmed cell death via apoptosis. Thus, our laboratory is synthesizing peptidomimetic derivatives that are based on the San A macrocyclic scaffold in order to improve the ADME properties of the derivatives over that of the macrocyclic peptide templates. Our San A peptidomimetic derivatives are synthesized via a combination of solid and solution phase peptide synthesis, and incorporate these peptidomimetic moieties: triazoles, oxazoles, thiazoles, and pseudoprolines.

Cracking the nitrogen triple bond: Iron and ruthenium dinitrogen chemistry

Ryan Gilbert-Wilson and Les Field
School of Chemistry

Abstract

The conversion of triple bonded dinitrogen that makes up 78 % of our atmosphere into other more reduced nitrogen compounds (nitrogen fixation), is essential for life. Nitrogen is part of the majority of biomolecules including nucleic acid and proteins. The natural processes of nitrogen fixation are no longer able to keep up with the worldwide demand for nitrogen based chemicals, with the industrial Haber-Bosch process now responsible for half of the fixed nitrogen that resides within the proteins of our bodies.

The Haber-Bosch process which uses a solid iron or ruthenium catalyst requires high temperatures and pressures resulting in the process being an enormous consumer of energy, mostly from natural gas. A more efficient and less energy intensive process is therefore very desirable.

Iron phosphines have demonstrated the ability to activate nitrogen, breaking the nitrogen-nitrogen triple bond and converting the nitrogen into more useful nitrogen-based chemicals like ammonia. This work further explores this class of compounds, successfully synthesising a range of new iron and ruthenium dinitrogen complexes and studying their reactivity, with a particular focus on complexes in which dinitrogen and hydride ligands are both located on a single metal centre.

Novel Antifouling Approach: Micro-Fabricated Surfaces for the Control of Marine Microbial Colonisation and Biofilm Formation

Gee Chong Ling and Staffan Kjelleberg
School of Biotechnology & Biomolecular Sciences

Abstract

An enhanced understanding of the processes that lead to rapid microbial biofilm formation in marine waters will facilitate the development of antibiofilm control technologies. Here we report on the effect of micro-fabricated polydimethy-siloxane (PDMS) surfaces, offering different architectural features, on the community composition and structure of the biofilm formed during 28 days of exposure in marine waters. First, the development of microbial biofilm structures was observed using confocal laser scanning microscopy (CLSM) and biofilm biomass quantified using 3D-CLSM image analysis. Second, the community composition of the attached microbial biofilm on these surfaces was studied using 16S-TRFLP. CLSM imaging revealed a different biofilm formation pattern, with surface topography smaller than 4?m preventing microcolony formation and hence altering biofilm development without impact on the biofilm biomass. 16S-TRFLP analysis of surface attached microbial communities revealed a successional pattern over time with no significant difference among surfaces. We conclude that the different micro- scale topographies used in this study impact on the attachment and development of surface associated microbial communities without altering the biomass or community composition during the time course of the experiment. Several mechanisms are likely to regulate this outcome, possibly including topography-related hydrodynamic forces and physical impediments on biofilm and microcolony development.

Sustainable Panel Materials from Forestry and Food industry by-products for the Built Environment

Andrea Wechsler and Veena Sahajwalla
School of Materials Science & Engineering

Abstract

Australia is the main commercial world producer of macadamia nuts, eucalyptus; and a large grower of radiata pine trees; generating large amounts of by products which are often treated as waste and sent to landfill; for example, in Australia the silviculture industries generate as much as 150 cubic meters of empty pinecones, and the macadamia nut industries generate as much as 28,000 tonnes of empty shells on an annual basis. These by products are under-utilised, often found in Christmas decorations, garden mulching, and animal fillers, or else incinerated, as their disposal in landfill is prohibitive, through sheer volume.

These by-products are available clean and dry after processing, and have excellent physical properties when exposed to high humidity environments. This makes them suited to applications such as composites panels for high moisture environments where dimensional stability, swelling and adhesive problems are often an issue.

This research presents results into composite panels made from forestry and macadamia industry by-products in Australia. The matrices of these composite materials have been chosen from recycled, non-toxic and organic bonding agents. Results are presented for the relevant morphological, emissions, physical and mechanical properties, and they are compared with conventional panels.

Nanoscale control of phase variants in strain-engineered $BiFeO_3$

Rama Vasudevan and Nagarajan Valanoor
School of Materials Science & Engineering

Abstract

Development of magnetoelectric, electromechanical, and photovoltaic devices based on mixed-phase rhombohedral-tetragonal (R-T) BiFeO(3) (BFO) systems is possible only if the control of the engineered R phase variants is realized. Accordingly, we explore the mechanism of a bias induced phase transformation in this system. Single point spectroscopy demonstrates that the T → R transition is activated at lower voltages compared to T → -T polarization switching. With phase field modeling, the transition is shown to be electrically driven. We further demonstrate that symmetry of formed R-phase rosettes can be broken by a proximal probe motion, allowing controlled creation of R variants with defined orientation. This approach opens a pathway to designing next-generation magnetoelectronic and data storage devices in the nanoscale.

WO3 Nanostructured Thin Film Prepared by Cathodic Electrodeposition and its Photoelectrochemical Properties

Wai Ling Kwong and Charles C Sorrell
School of Materials Science & Engineering

Abstract

Nanostructured tungsten trioxide (WO3) has shown great promise as photoelectrode material for the application in photoelectrochemical water splitting due to its remarkable stability in acidic aqueous environment, good electrical conductivity, non-toxicity and a small band gap of 2.6-3.0 eV, leading to the adsorption of a reasonable fraction of the electromagnetic spectrum. The large specific surface area which provides more active reaction sites and the absence of the conventional space-charge layer which resulted in different charge separation in a nanocrystalline WO3 play important role in surpassing its counter part (planar film) in photoelectrochemical performance. In this study, nanostructured WO3 thin films were synthesized by cathodic electrodeposition technique because it offers a cost-effective way to deposit adhesive large-area stoichiometric thin films on electro-conductive substrates at low-temperature without the need of expensive instrument. The films were potentiostatically deposited from peroxotungstic acid aqueous solutions and its photoelectrochemical properties were studied. Uniform WO3 nanostructured thin films were obtained and they demonstrated high crystallinity and optical adsorption upon annealing. The optical, structural and photoelectrochemical properties of nanostructured WO3 were found to be tailored by varying the concentration of tungsten, electrolyte pH, deposition potential, temperature and post-annealing.

Electric field-induced transformations in the lead-free piezoceramic 94%$(Bi_{1/2}Na_{1/2})TiO_3$-6%$BaTiO_3$

Hugh Simons and Mark Hoffman
School of Materials Science & Engineering

Abstract

The structural origin of the large electric-field-induced strain in bulk 94%$(Bi_{1/2}Na_{1/2})TiO_3$-6%$BaTiO_3$ has been investigated using in-situ neutron diffraction. This material is of particular interest as a substitute for lead zirconate titanate in high strain actuator applications. The unpoled structure shows an unusual combination of near-cubic phases with differing tilting modes of the oxygen octahedra and a periodic modulation of the atomic positions. An electric field was applied stepwise to a maximum of 4kV/mm with texture patterns collected at each field value. It was found that low-magnitute electric fields (<2kV/mm) increased the population and/or magnitude of the periodic modulation, while electric fields in excess of 2kV/mm induced a strong distortion of the oxygen octahedra. This high-field transformation was accompanied by splitting of the (111)/(1-11) and (200)/(002) peaks with a pronounced orientation of the c-axis along the field direction. The stepwise removal of the electric field revealed partial reversibility of the induced structure. These field-induced structural effects are shown to contribute to the large macroscopic strain and polarization and provide a structural description of the dielectric and electromechanical behaviour of this system.

Self-poled PZT thin films for hybrid solar cells

Jason Chen and Nagarajan Valanoor
School of Materials Science & Engineering

Abstract

With the rapid rise and growth of countries like China and India, finding a renewable source of energy has become increasingly important for sustaining economic growth while avoiding placing extra burden on the environment as global pollution has become both a serious environmental and social issue.

Till now, solar energy is still considered the most viable source of renewable energy, but as the efficiency of commercial cells is approaching only around 15%, there lies great opportunity for improvement. One of the biggest drawbacks to the silicon dominated solar energy market is the great cost of manufacturing which has so far prevented solar energy from mass uptake. In recent years, organic photovoltaic materials have emerged as a candidate for replacing silicon as it is easy and inexpensive to manufacture. However, the main disadvantage is low device efficiency due to the recombination of photo-induced electron and hole pairs.

This project aims to utilize the self-poling effect in ferroelectric materials to establish a built-in electric field in an organic photovoltaic/ferroelectric heterostructure that enhances the collection of photocurrent and consequently increase the overall efficiency in organic solar cells. This project could potentially bring further understanding to the physics behind organic photovoltaic materials and hopefully bring us a step closer to solving one of the biggest problems faced by current society.

Aerosol Drug Delivery in the Inhaler

Zhenbo Tong and Runyu Yang
School of Materials Science & Engineering

Abstract

An inhaler is a medical device used for delivering medicine into the lungs. It is mainly used in the treatment of the diseases like asthma and so on. Annual global market for novel drug delivery systems is valued at about $100 billion. The big issue is poor delivery efficiency and the highest efficiency of DPI products is 35%. We couples simulations using computational fluid dynamics (CFD) and discrete element method (DEM) with experimental dispersion analysis to improve the efficiency of dry powder inhalers. Develop fundamental understanding of the dispersion mechanisms of powders as aerosol for inhalation drug delivery and apply this understanding to the better design of dry powder inhalers. I believe that these technologies will produce inhalers with better performance to enhance the benefits to the patient in the world.

Structure analysis and modelling of the packing of ternary mixtures of spheres

Liangyu Yi and Aibing Yu
School of Materials Science & Engineering

Abstract

The packing of multi-sized particles is important to many industrial processes. While the packing structure often determines the process performance, it is not easy to be obtained experimentally and the fundamental understanding of it is far from well known. This work has presented a numerical study of the packing of ternary mixture of spheres with size ratios of 24.4/11.6/6.4 (approximately 4:2:1) by means of the discrete element method (DEM). Good agreement between the simulated and measured coordination numbers was obtained, which validated the DEM model at a particle scale. By the reliable and well controllable numerical experiments, rich and detailed data were generated and analysed, and a model was established to predict the coordination number of the ternary system with any volume fraction ratios of the components. The structure was further analysed by the so-called radical tessellation, which divides the whole packing into unit cells, each containing a single particle. The detailed topological and metric properties of radical polyhedron were studied and modelled against particle size distribution. The present study provides a comprehensive and insightful understanding of the packing structure of the ternary mixtures of spheres, and could be further extended to the general multi-sized systems.

Highly Photocatalytic Titanium Dioxide Spheres

Xiaohong Yang and Aibing Yu
School of Materials Science and Engineering

Abstract

Monodispersed titanium dioxide (TiO2) spheres with enhanced photocatalytic activity have been synthesized via a simple but efficient method at room temperature. By this method, the monodispersed titanium glycolate colloids can be first generated with diameters of 60-1000 nm by optimizing experimental parameters (e.g., concentration, time, and temperature). The proposed approach shows a few unique features, including: short reaction time (within a few minutes), high yield, and reproducibility. These titanium glycolate colloids can be further processed to be TiO2 particles with large surface areas via hydrothermal treatment at 100 °C or calcinations at around 500 °C, confirmed by various advanced techniques (TEM, TGA, FTIR, XRD, BET and ESI). Interestingly, the enhanced photocatalytic activity of these TiO2 nanoparticles was finally confirmed by measuring the decolourization of organic dye molecules (e.g., phenolphthalein) under UV irradiation.

Mixing of Wet Particles in Rotating Drums

Peiyuan Liu and Runyu Yang
School of Materials Science & Engineering

Abstract

Mixing of particles in a rotating drums is very complicated. Understanding the underlying mechanism is important for both scientific research and engineering applications. The mixing dynamics is further complicated by the presence of moisture which causes significant variation of granular mixing behaviour due to the capillary induced cohesion. This study is to investigate the mixing behaviour of wet particles in rotating drums using the discrete element method (DEM), aiming to understand the effects of liquid property and drum operation conditions on mixing behaviour.

Magnesium-Based Bio-absorbable Metallic Glasses

Yang Cao and Michael Ferry
School of Materials Science & Engineering

Abstract

Significant recent attention has been focused on magnesium and its alloys for use as bio-absorbable orthopaedic fixation devices. Most studies concerned commercially available grades of crystalline alloys, which were not originally designed for in vivo use. Recent advances in materials science have enabled the synthesis of bulk metallic glasses (BMGs) entirely from Mg, Zn and Ca constituents. Individually, these elements play important roles as nutrients and can lead to health benefits. These BMGs also exhibit superior corrosion resistance, increased strength, and can be readily shaped into intricate components using superplastic forming techniques. Hence, Mg-based BMGs are worthy candidates as bio-absorbable biomaterials.

In the present work, a series of BMGs based on Mg-Zn-Ca were synthesized using an in-house inverted die casting facility then cast into copper moulds to the final shape. Subsequent characterization showed superior corrosion resistance compared to conventional magnesium alloys. In vitro cytotoxicity studies also revealed that these bio-absorbable BMGs can support cell activity necessary for bone repair.

Towards Functional Fluorous Surfactants Based on Heterocycles

Dominic Francis and Roger Read
School of Chemistry

Abstract

New small fluorous molecules are under development that are designed to have typical fluorous materials properties, such as extreme hydrophobicity and lipophobicity, low surface tension, and high gas-dissolving capabilities, but exhibit additional functionality or reporter capabilities. Fluorous surfactants are known to readily self-assemble to form stable, highly-organized structures such as micelles, tubules, vesicles and even multi-layers, and efforts are being made to modify model surfactant-like molecules, through key amino substituents, to bring about this added functionality. The project involves a mixture of design and organic chemical synthesis, as well as measurement of physical and spectroscopic characteristics to determine self-assembly behaviour and structural motifs. It is intended to eventually demonstrate the principals of the proposed functionality in specific situations.

A Development of KJMA Kinetics for Applications in a more Complex Chemical Reaction System

Wu Ming Chen and Aibing Yu
School of Materials Science & Engineering

Abstract

KJMA model is the most generally accepted kinetics to describe Chemical Reaction Systems (CRS) with a stable product, but cannot describe the one with a metastable product. For example, the KJMA equation was the best theory to describe superconductor Bi-2223 crystal growth and determine its exponential index of growth, n, and activation energy, E. Unfortunately, difference of determined E was as high as ten times, but researchers didn't know what happened with it. To develop the KJMA kinetics, we combined the KJMA equation and its second term to develop a new equation, which can well describe formation and decomposition of metastable product in a CRS. We utilized the developed KJMA equation to study Bi-2223 crystal growth, the E and n were found to be time dependent of functions, values of which can be positive, zero or negative. The negative E and n were reported here for the first time, which relate to the decomposition of Bi-2223 crystal. The developed KJMA equation can describe a class of CRS with product in a stable and/or in metastable state. As a universal theoretical tool, it is expected to be widely applied to the science and engineering multidisciplines and their related interdisciplines.

living well + ageing well

Running Puts Stem Cells on Track!

Joyce Siette and Fred Westbrook
School of Psychology

Abstract

Memory impairments in later life are extraordinarily common, ranging from almost universal self-reported mild memory complaints, to the more severe memory problems associated with dementia and neurodegenerative diseases. It is thus critical to develop preventative strategies for combating the effects of brain ageing. To date, studies of cell therapy and exercise individually offer remedial strategies for decreasing impaired function and behaviour. The current experiment aimed to identify the additive effects of these two approaches. Aged rats were assessed on the object recognition (perihrinal-dependent) and place recognition (hippocampal-dependent) memory tasks prior to receiving a cell transplant or sham transplant, and were allowed to exercise for 6 weeks. We found that aged animals were impaired on the place task only. Groups that received either running, cell transplant, or both, dramatically reversed this impairment. Additionally, histological results show that transplanted cells migrate successfully to areas critical for memory formation and retention. Exercise may further improve this migration and promote cell survival. Epidemiological and clinical studies already suggest that physical exercise may be an effective preventative strategy against dementia. By contrast, cell therapy remains an experimental approach in animals, where control of cell fate is a major obstacle to clinical translation. Here, in a naturalistic animal model of memory dysfunction, our exciting findings indicate that exercise plus cell therapy leads to better memory outcomes than cell therapy alone.

Naturally-inspired antimicrobial peptide: Panacea for bacterial infections on biomaterials?

Ren Chen and Naresh Kumar
School of Chemistry

Abstract

Biomaterials are used in a variety of medical devices and implants, such as catheters, prosthetic implants and contact lenses. The use of biomaterial implants and medical devices is an increasingly common and often life-saving procedure. However bacterial infections on biomaterials have emerged as a major problem, accounting for approximately 45% of all hospital-acquired infections.

Consequently there is an urgent need to develop surfaces which resist bacterial adhesion and colonisation. Our research group and collaborators have developed a cationic peptide "Melimine", with excellent broad-spectrum antimicrobial activity. In this study we explored the ability of Melimine to prevent bacterial adhesion in vitro and in vivo when covalently tethered on biomaterial surfaces. Melimine-coated surfaces showed a significant reduction in bacterial adhesion when observed under confocal microscopy. Furthermore a half log reduction in viable bacteria was observed in the test group compared with the control group in a subcutaneous mouse model after 5 days. Coating of biomaterial surfaces with Melimine represents a promising strategy for the prevention of device-related infections.

"The cancer is cured… now what?" Examining the role of autobiographical memory and future imaginings in the adaptation of young cancer survivors

Ursula Sansom-Daly and Richard Bryant
School of Psychology

Abstract

Approximately 1200 adolescent and young adult (AYA) Australians aged 15-25 years are diagnosed with cancer each year, complicating an already challenging developmental stage as they strive for autonomy and an increased sense of self. Research indicates that AYAs are at a higher risk for 'post-cancer distress', and their perceived post-cancer identity is closely linked with adjustment into survivorship. Despite this, little research has explored the role of autobiographical memory in perpetuating this distress. This study drew upon Conway and Pleydell-Pearce's (2000) Self-Memory System, to explore cognitive mechanisms such as AYAs' ability to integrate the cancer experience into autobiographical memory and their sense of self, and generating adaptive representations of their selves into the future. Using a sample of high and low health-anxious undergraduate students as a model for post-cancer concerns (e.g., fear of recurrence), several tasks examined autobiographical memories, self-defining memories, and future imaginings, as a function of induced ruminative thinking style. Individuals in the high health anxiety group recalled more health/illness-related memories and future imaginings. A significant interaction also emerged whereby inducing ruminative self-focus in high, but not low, health anxious participants led to memories and future imaginings that were more negative and less specific. Implications for post-cancer adaptation are discussed.

Cholesterol + Brain = Good Fighting against scientific dogma

Eser Zerenturk and Andrew Brown
School of Biotechnology & Biomolecular Sciences

Abstract

What do you think of when cholesterol is mentioned? Bad things like fatty food and heart disease? What about dementia? Although there is a lot of focus on cholesterol as the bad guy, recent studies on Alzheimer's Disease (AD) are actually showing the opposite. In fact, low brain cholesterol levels have been linked to the production of the β-amyloid plaque (Aβ, the bad guy) which causes AD. Furthermore, low levels of some of the enzymes that produce cholesterol are an indicator of AD. My work focuses on one such enzyme, Selective Alzheimer's Disease Indicator-1, (Seladin-1), which directly affects brain cholesterol levels. By elucidating how our body regulates this enzyme, we hope that this will lead to the discovery of methods for "switching it on" and thus stopping the progression of AD. Oh, and cholesterol will finally get to wear the red cape!

Erasing traumatic memories

Wan Yee Chan and Gavan McNally
School of Psychology

Abstract
Disorders of fear and anxiety impose a significant burden on individual sufferers, their families, and communities. Existing treatments for such anxiety are effective but anxiety is prone to relapse after treatment. There is a pressing need for new approaches to treat anxiety and to reduce relapse following such treatment. One such approach is to exploit the recent finding that memories are continuously being destabilized, updated, and reconsolidated. Approaches which augment traumatic memory destabilization or interfere with reconsolidation may cause that memory to be lost forever. These approaches will produce a fear loss which is more long lasting and less sensitive to relapse. The research presented here addressed this possibility in three experiments using an animal model for the treatment of fear and anxiety. The results show that destabilizing a fear memory prior to fear reduction treatment produces a deeper or greater fear loss than is observed when fear reduction treatments are conducted in the absence of such destabilization. These findings suggest that memory destabilization and reconsolidation processes may be useful targets in the development of novel approaches to treat anxiety and fear.

Social Cognitive Deficits in Schizophrenia: A Psychophysiological Examination of Potential Underlying Mechanisms

Kandice Varcin, Julie Henry and Simon Killcross
School of Psychology

Abstract

Social cognition broadly refers to the means by which individuals perceive, interpret and process information in social contexts. In schizophrenia, social-cognitive impairment is a replicable finding, and has been linked to poor social functioning. These social difficulties are largely refractory to pharmacological intervention and are amongst the most disabling features of this disorder. It is therefore important to delineate the mechanisms underlying social-cognitive abnormalities in this group in order to identify appropriate targets for remediation. In non-clinical individuals, the tendency to spontaneously and rapidly synchronise facial expressions with observed expressions has been consistently linked to social-cognitive function. By using facial electromyography (a sensitive measure of subtle changes in facial muscle activity), my research was the first to show that individuals with schizophrenia do not demonstrate this rapid facial mimicry response (Varcin, Bailey & Henry, 2010). My research has also demonstrated that rapid facial mimicry is not a mere motor-matching response (whereby observing a facial expression automatically elicits a matching muscular response); instead, my research has shown that rapid facial reactions reflect emotional processes (Varcin, Henry, Bailey, & Richmond, submitted). Taken together, these findings suggest that disrupted rapid emotional responding may be one mechanism contributing to social-cognitive impairment in schizophrenia.

Sensors to monitor the health of eyes

Bakul Gupta and Justin Gooding
School of Chemistry

Abstract
Ageing macular degeneration (AMD) is one of the leading causes of blindness in Australia and across the world with 60% of the population over 50 suffering from it. What makes it so chronic is its inability of being detected early and a continued long-term dose of drugs and intravitreal injections. This frequent use of injections and visits to an ophthalmologist makes it a tedious and a cumbersome disease. AMD leads to blurred vision and increased inflammation in the eye, which is caused by the increased activity of the cells to release certain enzymes called proteases.

The aim of proposed research is to develop optically active porous silicon (PSi) microparticles that can simultaneously monitor protease activity in vivo using the intrinsic near-infrared reflectance of the particles and deliver therapeutic agents. To detect protease activity, the pores of the PSi particles will be filled with an enzyme substrate, gelatin. The proteases will then penetrate into the photonic crystals and degrade the gelatin inside the pores. This will cause a shift in the wavelength of reflected light that can be read out with an ex vivo detector. Because PSi erodes to benign products in the body, it is an ideal nanomaterial for in vivo applications. The results will demonstrate a new type of multifunctional nanostructure with a low-toxicity degradation pathway for in vivo applications. The degradation of gelatin can also be used to release a therapeutic, for example a gelatinase inhibitor, thus providing a technology that can simultaneously diagnose and treat; with the gelatinase activity controlling the rate of therapeutic release.

Cholesterol and ... prostate cancer?

James Krycer and Andrew Brown
School of Biotechnology & Biomolecular Sciences

Abstract

It is common knowledge that high blood-cholesterol levels are a risk factor for heart disease. However, almost a century ago, cholesterol was found to be more than just a metabolic by-product. Cholesterol is essential for the 'cell economy', being an important raw material for cell growth. In fact, emerging evidence is providing many compelling links between cholesterol and cancer (uncontrolled cell growth).

This is particularly the case for prostate cancer, the commonest cancer to afflict men worldwide. For instance, studies have associated the high-fat, high-cholesterol 'Western' diet with an increased risk of prostate cancer. Exploring this at a molecular level, my project has found that signals driving prostate cancer growth (e.g., male sex hormones) also stimulate these cells to accumulate cholesterol. Targeting this with cholesterol-lowering drugs (statins) reduced the growth of advanced prostate cancer cells, which has also been shown in animal models and clinical trials. Together, this suggests cholesterol fuels prostate cancer growth.

Given that prostate cancer is the second largest cause of cancer-related death among Australian men, and with a rising incidence given an ageing male population, there is a need to better understand this cancer to improve current treatment strategies. Could targeting cholesterol be the answer

Yeast genome-wide analysis identifies cellular processes affecting aggregation of amyloid beta 42-GFP fusion reporter

Suresh Nair and Ian Dawes
School of Biotechnology & Biomolecular Sciences

Abstract

Alzheimer's disease (AD) is the leading cause of dementia in individuals over 65 years of age; and the risk of developing Alzheimer's disease increases steadily with age. Amyloid-beta (Aβ) plaques, composed of aggregates of Aβ peptides, are a major neuropathological feature of AD. The two major isoforms of Aβ peptide are Aβ40 and Aβ42, of which the latter is highly prone to aggregation and shown to support a central role in AD disease progression. The increased presence and aggregation of intracellular Aβ42 peptides has been shown to be an early event in the disease progression of AD. Improved understanding of cellular processes involved in Aβ42 aggregation may have implications for our understanding of AD disease progression and possible development of therapeutic strategies.

In this study, Aβ42 fused to GFP (Aβ42GFP) was expressed in each mutant of the Saccharomyces cerevisiae genome-wide deletion library, to identify on a genome-wide scale the proteins and cellular processes that affect intracellular Aβ42 aggregation by assessing the fluorescence associated with the Aβ42GFP reporter. The genome-wide screening identified 98 mutants exhibiting intense Aβ42GFP-associated fluorescence. These deletion mutants were categorised according to broad biological functional groups/cellular processes based on the established or putative cellular roles of each of the respective 98 gene products. This approach identified four major cellular processes that were over-represented in the data set, of which mutants that were categorised into the lipid homeostasis functional group is discussed.

Are tear proteins essential for good vision?

Siva Balasubramanian and David Pye
School of Optometry & Vision Science

Abstract

Human tears are rich in proteins and help to provide nourishment to the cornea, which is located at the front of the eye. A normal spherical cornea is essential for good vision. Keratoconus is a disease condition which alters the corneal shape and can therefore produce severe visual impairment.

Thin capillary tubes were used to collect human tears and shape of the subject's corneas was measured. The total proteins and major individual proteins in human tears were analyzed. The association between tear proteins and severity of keratoconus was studied. The tears of people with keratoconus were deficient in certain tear proteins and these levels decreased as the disease progressed.

Since tears are spread over the cornea, the tear proteins might affect, or be affected by the altered corneal shape in Keratoconus. Appreciating the cause for low levels of tear proteins might be vital to slow or prevent vision loss from this condition.

Social anxiety and the effects of negative self-imagery on emotion, cognition, and post-event processing

Steve Makkar and Jessica Grisham
School of Psychology

Abstract

Numerous studies have shown that social phobia patients experience negative self-impressions or images during social situations. Clark and Wells (1995) posited that such negative self-images are involved in the maintenance of social phobia. Thus, the present study investigated the effects of negative self-imagery on cognition and emotion during and following a brief social situation. Specifically, high and low socially anxious participants (N = 77) were instructed to hold either a negative or control self-image as they engaged in a brief speech. Participants then rated their anxiety, performance, cognitions, and focus of attention. Twenty-four hours later, they returned to the laboratory and completed questionnaires assessing the amount of post-event processing (PEP) they engaged in. The results showed that, irrespective of the level of social anxiety or depressive symptoms, participants that held the negative self-image experienced higher levels of anxiety, were more self-focused, experienced more negative thoughts, rated their anxiety as more visible, appraised their performance more negatively, and engaged in more negative and less positive PEP than participants that held the control self-image. Collectively the results indicate that negative imagery is causally involved in the maintenance of social phobia, as well as in the generation of social anxiety among non-anxious individuals.

science +
society

What is your contact lens storage case?

Yvonne Wu and Fiona Stapleton
School of Optometry & Vision Science

Abstract

There are 125 million contact lens users worldwide. Epidemiological studies have confirmed that poor contact lens case hygiene may cause microbial keratitis, a sight-threatening condition. However, there are limited data on how to clean contact lens cases. This study experimentally evaluated and compared the effectiveness of various cleaning procedures in removing biofilm from contact lens cases, hoping to provide lens case hygiene guidelines for lens wearers, practitioners and the industry.

Bacterial biofilms were formed on lens cases. Each lens case was then subjected to one of the following cleaning methods: rinsing with disinfecting solution, rubbing with fingers, wiping with tissues, air-drying for 6 hours, and recapping lids for 6 hours. The residual bacteria after each cleaning procedure was quantified. The most effective cleaning procedures that were then tested sequentially.

Air-drying and recapping the lids had no effect in removing biofilm ($p>0.9$). Rinsing with solution elicited a marginal anti-bacterial action. Rubbing lens cases and wiping with tissues were the most efficient, and these two cleaning methods combined provided the optimum results ($p<0.001$).

Applying a shearing-force (rubbing and wiping) to lens cases is the most effective method in removing biofilm. Recapping the lens case lids or air-drying alone should be discouraged.

Tsunami Impact: Surfing the Wave to Disaster Reduction

Cameron Tarbotton and James Goff
School of Biological, Earth & Environmental Sciences

Abstract

Recent disasters resulting from the 2004 Sumatra-Andaman and 2011 Great Eastern Japan tsunamis have brought tsunamis to the forefront of public discourse. The scale and extent of the damage caused by these events is devastating. Alarmingly, such disasters are expected to become more frequent as human development pushes increasingly into tsunami-prone coastal regions. More so than ever, it is vitally important to develop tools that can predict the impact that future tsunamis will have on the built environment. Only then can communities effectively prepare for, respond to and recover from future events. Presented in this paper is an integrated approach for doing just this. It combines tsunami inundation modelling techniques and detailed geospatial data into a web-based tsunami vulnerability assessment tool. This tool provides an effective means for planners and emergency managers to quantify the risk posed by tsunamis, offering both a sound methodology for assessing the vulnerability of buildings to tsunami, as well as a collaborative and easy to use platform for conducting community-wide studies. Ultimately, this will provide an important means of reducing risk by informing decisions regarding land-use policy, building codes, evacuation plans and public education.

The role of midbrain dopamine in attention and learning

Susan Li and Gavan McNally
School of Psychology

Abstract

Cognitive deficits are a core feature of schizophrenia. These deficits include an inability to down-regulate attention. Hence, people with schizophrenia frequently attend to and learn about (i.e. associate) events and relations in the world that are spurious or not causally connected. My research uses an animal model to study the brain mechanisms and pathways that normally act to prevent this loosening of associations. The experiments to be reported study the role of midbrain dopamine neurons in the allocation of attention and learning among competing stimuli which differ in their reliability as a signal for danger. People with schizophrenia perform poorly in this task. The results showed that whereas control rats could learn to ignore a stimulus which was not a reliable predictor of danger, rats which had received a pharmacological modulation that increases activity of midbrain dopamine neurons could not. These results suggest that dysregulation of signaling in midbrain dopamine neurons may contribute to deficits in attention and learning in schizophrenia.

Differential effects of alcohol consumption and alcohol contexts on racial bias in shooting decisions

Timothy Schofield and Tom Denson
School of Psychology

Abstract

Research suggests that alcohol impairs one's ability to inhibit hostile racial stereotypes. Such stereotypes explain the existence of the so-called "racial shooter bias" in which White participants tend to shoot at unarmed Middle-Eastern targets more often than unarmed White targets. Study 1 found that alcohol intoxication exacerbates the racial shooter bias. However, participants given a placebo beverage showed a reversal of this racial shooter bias: they were more likely to shoot White targets than Middle-Eastern targets. Study 2 showed that priming participants with images of alcoholic beverages compared to non-alcoholic beverages also reversed the racial shooter bias. However Study 3 shows that the reduction in racial shooter bias caused by alcohol contexts in Studies 1 and 2 is not attributable to compensatory increases in inhibitory control. Specifically, Study 3 showed that alcohol primes, compared to neutral beverage primes, reduced inhibitory control in a Go/No-Go task. Although the exact mechanism by which an alcohol context attenuates and reverses the racial shooter bias is unknown, it does appear to be a consistent result of both alcohol placebos and alcoholic beverage priming.

Eyes in the Sky Could Help Save Millions of Lives

Mehrnoosh Johnstone and Aibing Yu
School of Materials Science & Engineering

Abstract

Scientists are turning to imaging technology in order to help predict when cholera will break out in "cholera hotspots" around the world. Health experts aver that today's cholera outbreak has been present since 1961, making this current outbreak the longest-running outbreak in the history of mankind. One reason for the current protracted outbreak is that cholera strains have mutated into one that is more drug-resistant, more resilient and more toxic than ever. Satellite imaging tools are used to provide images of the bodies of water where the potential for the extraordinary growth of this plankton may take place. Other sensors on these satellites also are able to measure the levels of chlorophyll growth, sea surface temperature and light. If the sanitation in these coastal areas is poor, such as in some developing nations, then the bacteria moves into the drinking water systems of these cities, and the outbreak is massive, and health officials become overwhelmed because they are ill-prepared to fight the outbreak. Thus, the powerful tools that increase the accuracy of prediction of outbreaks combined with the educational programs that teach those who may be affected to protect themselves from infection may help millions of lives around the world.

The role of mPFC subregions in reacquisition and renewal of extinguished alcoholic beer-seeking

Andrea Willcocks and Gavan McNally
School of Psychology

Abstract

Evidence suggests that there is a clear dissociation between the roles that dorsal and ventral mPFC subregions play in the reinstatement of drug-seeking behaviour. Specifically, the prelimbic (PL) has been implicated in the initiation of drug-seeking whereas the infralimbic (IL) and dorsal peduncular (DP), appear to be crucial for the inhibition of drug-seeking or expression of extinction. This divergence stems from research that uses reinstatement paradigms which test subjects drug free and hence lack a crucial component of lapse episodes. In the current experiments, mPFC subregions were temporarily inactivated using infusions of GABA agonists baclofen/muscimol prior to a reacquisition test (reintroduction of drug reward) and renewal test (drug free test of context-induced reinstatement). The role of mPFC subregions were assessed in terms of their role in the onset of drug-seeking (latency to first active nose-poke) and overall levels of responding (responses on active and inactive nose-poke). The results show that, in the absence of PL, responding was sensitive to the current contingency, whereas in the absence of IL, onset of responding was sensitive to contextual cues. Hence, evidence for the proposed prelimbic-reinstatement/infralimbic-extinction dichotomy was not observed when examining behaviour with (reacquisition) and without (renewal) the drug reward.

Developing New Anti-Cancer Agents

Hamish Toop and Jonathon Morris
School of Chemistry

Abstract

Leukaemia is a cancer of the bone marrow and blood and contributes to approximately 4 % of all cancer related deaths worldwide. Current treatment of leukaemia relies on drug regimes which ultimately kill cancer cells. Despite the progress that has been made for the treatment of leukaemia, patients with the disease eventually develop resistance to these therapeutics and die.1 It is therefore imperative that new drug treatments are discovered.

The amino alcohol AAL(S) has been found to kill various leukaemia cell lines. Importantly, the compound effectively eliminates cells that are resistant to current therapeutics and does not affect normal blood cells.2 As such, it has great potential as a therapeutic agent. However, despite its interesting activity little is known about the mode by which AAL(S) works. To ensure that the best drug is developed, we are focused on determining how AAL(S) works and refining the structure. This will be achieved using a combination of medicinal chemistry and molecular biology.

Disentangling the effects of anger and disgust on moral judgment: Towards a physiological marker of 'moral disgust'

Alexis Whitton and Julie Henry
School of Psychology

Abstract

Research has shown that inducing feelings of disgust increases the severity of an individual's moral judgments. However, some studies have also implicated anger, raising the question of whether moral judgment is influenced by negative emotions more generally. The current research aimed to provide the first direct comparison of anger and disgust on responses to moral transgressions, using highly sensitive physiological measures of emotionality. Furthermore, this research aimed to identify whether a physiological marker of 'moral disgust' exists, that can be distinguished from negative responding in general. Participants (N = 90) were randomly allocated to one of three groups in which either disgust, anger or no emotion was induced. Responses to images depicting moral, negative yet non-moral, and neutral themes were then recorded using facial electromyography. Inducing disgust, but not anger, was found to increase physiological responding specifically to moral themes. Additionally, activation of the levator labii muscle - the muscle next to the nose which retracts during facial expressions of disgust – was able to distinguish moral from negative non-moral themes. These findings imply a unique role of disgust in the perception of moral transgressions, and provide a platform for the investigation of a physiological profile of moral disgust.

Oils in the eye!!

Athira Rohit and Fiona Stapleton
School of Optometry & Vision Science

Abstract

About a hundred and twenty million people wear contact lenses worldwide. Despite the popularity of contact lenses, 75% of lens wearers experience ocular discomfort and dryness prompting many of them to reduce wearing time or to discontinue from lens wear entirely. Among the various factors contributing to contact lens wear discomfort, the stability of tear film structure is a key. The lipid layer is the outermost oily layer of the tear film and acts as a vital component in preventing evaporation of tear and is identified as a crucial element of both tear film stability and ocular comfort. Contact lens causes an unstable tear lipid layer and this instability may be one of the contributing factors for contact lens wear discomfort. But an evidence based assessment of whether artificial lipid supplements can improve ocular comfort during contact lens wear and the underlying biological reason for the change is missing in the previous literature. This study aims to establish the association between comfort in contact lens wearers and structural and functional changes in tear lipid layer. A second objective of this research study is to examine associations between clinical, functional and biological components of tear film lipid layer and discomfort. The preliminary study will be presented in the poster.

The Illusory Depressive Realism

Shruti Venkatesh and Michelle Moulds
School of Psychology

Abstract

Contingency learning involves learning the association between two events, such as learning that a red light means stop. Past studies have found that when people are given a contingency task involving an outcome that occurs frequently, regardless of a person's response, people tend to develop the false belief that they have control over the outcome. This is referred to as an illusion of control. Interestingly, there is evidence to suggest that depressed individuals do not demonstrate an illusion of control; a phenomenon known as depressive realism. Depressive realism is ostensibly incompatible with the general understanding of depression as a condition associated with maladaptive and negative thinking. My research furthers understanding of the robustness and generalizability of depressive realism. Of the 12 studies that I conducted only limited evidence for the existence of depressive realism was found. This suggests that depressed individuals are generally no more accurate than non-depressed individuals when judging their degree of control over an outcome. Hence, depressive realism seems to arise in a rather narrow context with the general rule being that people, regardless of their levels of depression, succumb to an illusion of control. Thus the purported advantage of being depressed seems to be an illusion.

Association of Single Nucleotide Polymorphisms of Interleukin 1ß, 6 and 12B and Susceptibility and Severity of Keratitis amongst Contact Lens Wearers

Nicole Carnt and Fiona Stapleton
School of Optometry & Vision Science

Abstract

Purpose: To investigate whether SNPs of IL-1ß, IL-6 and IL-12B are associated with susceptibility and severity of contact lens related keratitis.

Methods: 112 cases of keratitis and 215 controls were recruited from studies conducted at Moorfields Eye Hospital and in Australia during 2003-2005. Buccal swab samples were collected on Whatman FTA cards via post. IL-1ß (-31), IL-6 (-174, -574, -597) and IL-12B (3'+1158) genotypes were analysed with Pyrosequencing and investigated with regression for susceptibility (sterile, microbial keratitis, controls) and severity. $P<0.05$.

Results: Carriers of IL-6 SNPs were more likely to experience severe events compared to non-mutated genotypes (-174 heterozygous, OR 3.1, 95% CI 1.1 – 8.3; homozygous, OR 6.4, 95% CI 1.4 – 28.4; -174/-597, OR 4.1, 95% CI 1.6-11.0). The IL-12B non-mutated genotype had lower risk of sterile keratitis (OR 9.7, 95% CI, 1.2 – 76.9) compared to controls. The non-mutated haplotype -174/ 597 had greater risk of sterile compared to microbial keratitis (OR 3.5, 95% CI 1.3-9.5)

Conclusion: These associations suggest IL-6 decreases the severity and susceptibility of contact lens related keratitis and IL-12B is over-expressed in sterile keratitis.

Safety Management Systems for Heavy Vehicle Transport

Lori Mooren and Ann Williamson
School of Aviation

Abstract

This research project will involve two consecutive phases. The aim of the first phase is to identify the key elements of a model SMS for heavy vehicle transport. This phase will necessitate a critical analysis of key metric units used to assess the safety performance or incidents that distinguish the characteristics of heavy commercial road transport companies with high and low safety performance records. Sample companies will be chosen from a large insurance client database.

Using the characteristics that distinguish good performers, a broad SMS framework for heavy vehicle transport will be developed. The aim of the second phase is to use the results of the first phase to develop a safety intervention based on the characteristics most likely to produce the best safety outcomes. This SMS intervention will then be implemented in a range of heavy commercial road transport companies and evaluated, using in-vehicle telematics on random trucks and monitoring safety systems and practices in intervention and control companies.

Flight Safety and its Reliance on Cultural Attributes of Cabin Crew

Morteza Tehrani and Brett Molesworth
School of Aviation

Abstract

The role of cabin crew and their significance for cabin safety have been highlighted in several air accidents some of which could have been avoided if cabin crew had revealed the information they held. Nowadays major airlines embrace diverse cabin crew with various cultures whose performance may be affected by their behaviours.

The diversities and interrelationship of cultures can produce friction which may disintegrate a team and lose its synergy and cohesiveness. A good safety system should form a safety culture to foresee all aspects of cultural attributes the cabin crew present as they are selected from diverse groups and backgrounds.

This study will explore the attributes of the existing issues and the optimal character for the cabin crew to perform a safe and efficient operation. The findings of this research should highlight the weak areas of our flight operations.

In addition, it is anticipated that this study will develop a scientifically valid tool to identify safety culture within the cabin area. This tool has the potential application for various aviation organisations internationally. Furthermore, with minor modifications it is anticipated that the tool could be adopted in other complex socio-technical environments such as medicine, rail and marine.

Photoluminescence Study and Characterization of Optically Trapped InP Semiconductor Nanowires

Fan Wang and Peter Reece
School of Physics

Abstract

My work is mainly using optical tweezers to research physical and optical properties of semiconductor nanowires, especially InP nanowire with length of 5-15μm and diameter of 30-150nm. Recently semiconductor nanowires attract more interest for nano-scale optoelectronic integrated circuits and devices, due to its potentially function as both electrical and optical conduits. While optical tweezers is a powerful tool for manipulating single nanowire; combined with micro-photoluminescence it is effective for characterization and application of individual semiconductor nanowires. By means of back focal plane interferometery, the motion and trap stiffness of trapped nanowire can be quantitatively investigated, which can be used to research Brownian dynamics of nanowires and two nanowires' coupling dynamics. An IR trapping laser (1064nm) and a visible excitation laser (514.5nm) are used to characterize single nanowires' photoluminescence (PL) property including direct PL, two-photon absorption PL and second harmonic generation. For InP nanowire the PL property for different crystalline phases is researched also. Combined wave guiding and PL properties of nanowires can be used to nanowire scanning probe. While combing wave guiding with Bessel beam excitation, the potential trapping nanowire laser may be achieved.

Lesions of the Rat Prelimbic Cortex Contribute to Attentional Deficits Similar to those Observed by Patients with Schizophrenia

Melissa Sharpe and Simon Killcross
School of Psychology

Abstract

One of the features of schizophrenia is the excessive attribution of causality to irrelevant external stimuli. It is hypothesised that this trait contributes to positive symptoms (e.g. paranoid delusions and hallucinations). Research has suggested that this characteristic may be secondary to an underlying abnormality in attentional processing (Kapur, 2003). Specifically, it is believed that people with schizophrenia have a deficit in selectively attending toward stimuli that reliably predict motivationally significant events. Dominant theories of associative learning suggest that the amount of attention a stimulus is paid determines the degree to which that stimulus can enter into an association with an event (Mackintosh, 1975). Hence, an inability to attend selectively toward stimuli may lead to a tendency to attribute significance to irrelevant stimuli that are usually ignored. Research has suggested that prefrontal dysfunction contributes to this deficit in attentional processing (Howes & Kapur, 2009). Using Pavlovian conditioning in rats, we found that lesions of the prelimbic cortex, an analogue to the human dorsolateral prefrontal cortex, leads to deficits similar to those observed by patients. Broadly speaking, lesioned animals appear to respond to stimuli that are usually disregarded by controls. We hypothesise that this region contributes to an ability to downregulate attention toward irrelevant cues. Thus, dysfunction in this region may be a potential contributor to the attentional deficits contributing to the positive symptoms of schizophrenia.

Why are rare events ignored in experience-based choice?

Adrian Camilleri and Ben Newell
School of Psychology

Abstract

Life is filled with choices between uncertain alternatives, ranging from the trivial (like where to dinner and whether to carry an umbrella), to the life-changing (like whom to marry and which football team to support). The first step when making such risky decisions is to gather information about the potential outcomes and their associated probabilities. One information acquisition strategy is to seek out a summary description of the alternatives on offer. For example, when considering whether to carry an umbrella, you might check the online weather forecast for chance of precipitation. An alternative information acquisition strategy is to stick your head out of the window and compare the threatening clouds and with your previous experience of similar looking skies. It turns out that people use both of these strategies depending on the situation. The surprising finding, however, is that these strategies frequently lead to different choices being made. In particular, people tend to behave as if they fixate on the probability of a rare event when relying on a description, but largely ignore the probability of a rare event when relying on their own experience. My research program reveals the numerous factors that drive this description-experience choice "gap".

Assessment of vision- related quality of life in school age amblyopic children in Saudi Arabia using the UNSW-KSU Children's Vision for Living Scale

Kholoud Bokhary, Mei Boon and Catherine Suttle
School of Optometry & Vision Science

Abstract

There is a need to develop and validate a tool for children with amblyopia (lazy eye) in Saudi Arabia as there is presently no validated instrument have been developed to assess the effect of amblyopia and its treatment on quality of life in children that are part of the Saudi Arabian culture and society. Most of the currently available tools are develop and valid for children with amblyopia in Western countries.

We addressed this need by developing and validating a new tool called the UNSW-KSU Children's Vision for Living Scale based on a review of the literature and interviews of children with amblyopia and their families in Australia and Saudi Arabia (n=15). A culture-specific questionnaire was developed and tested in Saudi Arabia (n=179), analysed using Rasch methods and revised to include items relating to overall self worth, self esteem, social life, visual function, physical activity, behaviour and school performance. The final version of the questionnaire was tested in Saudi Arabia (n=101) and found to be valid and reliable (person reliability 0.86; item reliability 0.92) for that population. Using this scale, we found quality of life to be lower in children with amblyopia than in age-matched children with normal vision.

An Analysis of OHS Court Prosecution Decisions in Australia; Predominately NSW, in Identifying Whether Past OHS Legislative Practice in Implementation, Compliance and/or Enforcement (ICE) Influenced Contemporary OHS (MS) Practices

Hung Hua JP and Paul Adam
School of Biological, Earth & Environmental Sciences

Abstract

The endeavor to better understand the elusive dynamics of key decision-makers (i.e. employers and controllers) in OHS (MS) practices which have continued to disrupt the drive of Implementation, Compliance and/or Enforcement (ICE) of Occupational Health and Safety Management Systems (OHS (MS)) practices. The analysis took into consideration the trend between OHS failures (i.e. National v NSW (subset)) and the fatality/non-fatality (i.e. NOSI v Subset) and with the outcome, to introduce a new OHS (MS) ICE model (Management of Safe Systems of Work (MoSSoW)) that will assist employers to manage their ICE obligations. Therefore, with better understanding of OHS legislation and OHS (MS) practice requirements and clearer definitions could provide employers with better ways to deal with an array of misconceived workplaces practices.

The Potential of Anti-Psychotics and Statins as Chemotherapeutics

Nirmani Wijenayake G and Louise Lutze-Mann
School of Biotechnology & Biomolecular Sciences

Abstract

Glioblastoma Multiforme (GBM) is a malignant form of cancer that is difficult to treat. The median survival of a patient with GBM is only 1 year. In most cases, surgical resection is usually followed by radiotherapy and chemotherapy with Temozolomide, one of the approved drugs for the treatment of GBM. Unfortunately, large number of patients develop resistance against Temozolomide and other chemotherapeutics are unavailable for treatment due to their inability to cross the blood brain barrier. Therefore, there is a need for new potential chemotherapeutics against GBM.

Meta-analysis of cancer in schizophrenic patients suggests a lower incidence of some cancers leading to the hypothesis that antipsychotic drugs taken regularly by these patients may have the ability to act as chemotherapeutics. We have demonstrated the significant effect of number of antipsychotics in vitro with the use of short term cell viability assays and long term clonogenic assays. Previous studies indicated that cytotoxic effects of antipsychotic drugs maybe due to blockage of intracellular trafficking of exogenous and endogenous cholesterol. We have demonstrated the ability of lipophilic, cholesterol lowering statins to induce GBM cell death in vitro. By combining antipsychotics with statins, we have demonstrated an increased cytotoxicity of antipsychotics.

Our results established antipsychotics and statins as potential chemotherapeutic agents against GBM. The IC50 and LD50 values for these drugs are smaller and far superior compared to the current treatment, Temozolomide, increasing their value in the treatment of GBM.

Restoring Access to Embellistatin

Justin Nash and Jonathan Morris
School of Chemistry

Abstract

Cancer is a major cause of death worldwide and it is characterised by uncontrolled rapid cell growth. Disruption of cancer can be achieved by the use of drugs which can selectively target and inhibit processes vital to the growth of cells.

Microtubules are an established target for treatment as they are involved in many aspects of cell growth and are vital for the growth of new blood vessels. While treatments targeting these biological processes have been developed, there is an ever evolving resistance to current drugs and a need for a more active and selective therapeutic.

The natural product embellistatin represents a promising step forward as it targets both microtubules and angiogenesis. This compound is no longer available from its natural source, which has stymied progress. We are developing a total synthesis which will allow us to prepare the compound from readily available materials. By restoring access to this important molecule, we will be able to develop it as a new therapeutic agent.

Improved measurement of stable carbon isotope ratios of steroids in urine for the detection of steroid abuse

Ellaine Munton, Brynn Hibbert and John Murby

Abstract

Testosterone is a naturally occurring steroid that can be misused by athletes for its anabolic effects. The World Anti-Doping Agency (WADA) reported that results indicating potential testosterone abuse accounted for 46% of all adverse analytical findings in 2009, far more than any other form of doping. Administration of exogenous testosterone is confirmed by comparing the carbon isotope ratios of testosterone metabolites in the urine with those of endogenous reference compounds. A difference of 3 ‰ or more between these carbon isotope ratios (equivalent to a difference of 0.00327 % in the 13C mole fraction) is consistent with abuse. As these differences are very small, it is important that the measurements have minimal measurement uncertainty. This project aims to improve the quality of isotope ratio measurements for urinary steroids by optimising the extraction procedure.

Each step in the extraction was optimised for maximum recovery and minimal isotopic fractionation: Solid Phase Extraction (SPE) from the urine matrix; removal of the glucuronide conjugate with β-glucuronidase; Liquid-Liquid Extraction (LLE) from aqueous solution; and High Performance Liquid Chromatography (HPLC) purification. A new calibration and δ13C value calculation procedure was also developed in order to improve the estimation of the measurement uncertainty.

Frequent Hepatitis C Multiple Infections in a Prison Cohort

Son Truong Pham and Peter White
School of Biotechnology & Biomolecular Sciences

Abstract

Hepatitis C virus (HCV) infects 2-3% of the world's population, causing severe liver diseases. Recent data indicate infection with multiple HCV occurs, and are common among injecting drug users (IDU). In the present study, we sought to identify and characterise multiple HCV infections among incident HCV infected IDU inmates (n=87) enrolled into an Australian prison cohort. Multiple infections were detected using two reverse transcription - polymerase chain reactions targeting the Core region and the envelope glycoprotein-1 together with the hyper-variable region-1. Among 87 subjects, infection by two or more HCV were identified in 22 subjects (25.3%), with the prevalence of 31.3% and the incidence of 40/100 person-years (95% CI, 33-44/100 person-years) during follow-up. The rate of successful clearance of all viruses among 22 cases was 23/100 person-years (95% CI, 19-31/100 person-years). Spontaneous HCV clearance from one HCV and persistence of the other HCV was observed in eight cases. In these cases, the virus with higher HCV RNA level out-competed the other, suggesting that HCV RNA level is an important factor in viral competition and infection outcome. This study comprehensively analyses frequent multiple HCV infections in a high-risk cohort and provides further insights into infection dynamics after exposure to variant HCV.

Variation of pertussis toxin promoter (ptxP) and the re-emergence of Bordetella pertussis

Connie Lam and Ruiting Lan
School of Biotechnology & Biomolecular Sciences

Abstract

Variation of pertussis toxin promoter (ptxP) and the re-emergence of Bordetella pertussis Vaccines against pertussis, caused by the bacterium Bordetella pertussis, were developed in the 1950s, but due to side effects were replaced by acellular vaccines in the 1990s. Despite high vaccination rates, epidemic cycles of pertussis continue to occur, with the most recent Australian epidemic in 2008.

Isolates of B. pertussis have been characterised by changes in genes encoding antigenic components of acellular vaccines, including pertussis toxin. The production of pertussis toxin is controlled by the gene ptxP. In this study, the ptxP of 313 global B. pertussis isolates were sequenced. There were 2 predominant ptxP types: ptxP1 and ptxP3 which differed by a single base change. ptxP3 has been shown to be capable of inducing the organism to produce a higher level of toxin.

We found 73% of isolates carried ptxP1, and were largely older isolates collected prior to the introduction of the acellular vaccine. More interesting however, is the fact that the most recent group of isolates all carried ptxP3. Based on epidemiological data, we have shown that the ptxP3 emerged only after the introduction of the acellular vaccine in the 1990s. Together with other antigenic gene variations observed previously, our results suggest the change in ptxP allows current isolates to evade vaccine induced selection pressure and cause more severe disease.

Urinary Bladder Matrix in Conjunction with Laser Activated Chitosan-Based Bioadhesive for Sutureless Nerve Repair

Tania Ahmed and John Foster
School of Biotechnology & Biomolecular Sciences

Abstract

Biocompatibility of biomaterial-based scaffolds is pivotal for successful tissue repair and reconstruction in tissue engineering applications, particularly in spinal cord injuries. In vivo implantation of a potential biomaterial may trigger irreversible host immune responses leading to loss of function and impaired healing. Suitable biomaterials that can serve as nerve conduits for transplanting olfactory ensheathing cells (OECs) into damaged spinal cord to induce nerve repair and regeneration are required. Consequently, this study incorporated extracellular matrix derived from porcine urinary bladder (UBM), which has been shown to facilitate the recruitment of marrow-derived stem cells, with SurgiLux, a chitosan-based laser activated adhesive to potentially fabricate a therapeutic scaffold for sutureless nerve repair. Furthermore, this study examined the influence of incorporated UBM-SurgiLux® biomaterials on OECs at the cell-material interface by adopting a cell cycle, apoptosis and proteomics approach.

Cellular response at the material interface revealed a normal maintenance of regular morphology and enhanced growth of OECs compared to chitosan films alone. Cell cycle analysis revealed a significant difference in the DNA content of cell populations cultivated in the presence and absence of UBM-SurgiLux® films. Additionally, detection of early stage of apoptosis using Annexin V assay revealed significant deviations from standard culturing conditions as chitosan induced cell population to undergo early apoptotic activation. These results provide new insights into the nature of OECs and their response to their microenvironment which is of paramount significance for the success of UBM-SurgiLux® biomaterials that promote regeneration of neural tissue.

>>thanks

Thank you to all of the supervisors and other research colleagues for their participation in this event.

THANK YOU to the judging panel's huge effort, it was very much appreciated.