Lab+Life SCIENTIST

Telepathy and the internet

Frog venom and polymers

The roots of immune responses

NOVEMBER 2014
VOL.25 NO.5
PP100008671

ANALYTICAL | BIOTECH | ENVIRONMENTAL | INDUSTRIAL | LIFE SCIENCES | MEDICAL


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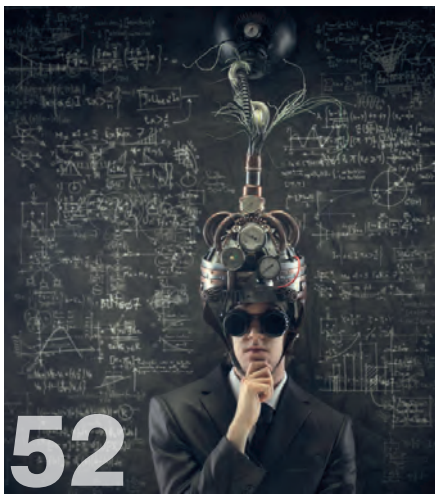

Cover image: Third place getter in the Nikon Small World 2013 Photomicrography Competition
Dr Alvaro Migotto, University of São Paulo, Centro de Biologia Marinha, São Paulo, Brazil

Subject Matter: Marine worm (20x)
Technique: Stereomicroscopy, Darkfield

Sometimes a graph is just a graph

So much is done under the aegis of 'science'.

Recently researchers from the Cornell University Food and Brand Lab established that if graphs or formulas accompany medical information, consumers are more likely to believe that the products are more effective, even if the graphs carry no additional evidence.

It seems that individuals are influenced by scientific-looking information simply because they perceive it to be true. Theoretically this puts a load of power into scientists' hands - but are we handling it properly?

The short answer is no. Every decent scientist believes in the scientific method and would not consider publishing results without measurable evidence based on systematic observation and experiment. This leaves the field wide open for marketers to exploit - usually for commercial gain for a few.

Scientists really need to take up marketing. Let's face it, we could conjure up some fantastic graphs to support our bid to increase scientific funding for the good of the broader community. At the same time we should produce some more quasi-scientific evidence to show why scientists need long-term tenure in their professional lives and salaries that reflect their education and contribution to society.

But wait a minute, the above points are true - we don't need to bodgie up some graphs and figures. On the whole, scientists are poorly remunerated and jobs are often contractual and rely on the whims of funding access. This means we can actually support our claims with real science.

So in fact, we need to learn from the marketers rather than mock them. We need to present our case in a compelling way explaining why science and scientists are essential. And we don't just need to convince each other that better funding models and better pay and conditions should be de rigueur.

We need to put our case to industry so that the value of scientific research is recognised and industry funding increases to levels comparable with the rest of the developed world. We need to convince government so that science is taken seriously and funding is not so short-sighted that the only funding is for work with outcomes expected within the life span of the current party in power.

We need the education system to value science so that science education is given higher priority with better, more inspiring curricula. We need the students coming through the school system to look forward to science lessons with anticipation and to genuinely think that a scientific career would be fantastic.

Every one of us needs to become a science marketer if we want to lift science to where it should be in the nation's psyche.

Susan Williamson

Janette Woodhouse

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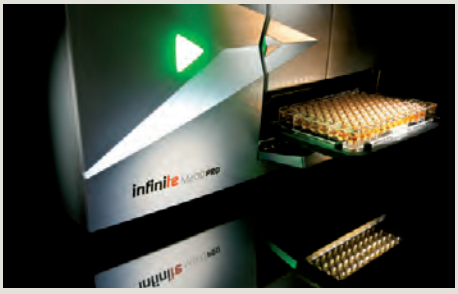

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Susan Williamson

Professor Andrew Holmes reflects on the role serendipitous discovery has played in his successful research career as an organic chemist and how he is now stepping into the role as President of the Australian Academy of Science.

The organic polymer chemist

Lab+Life Scientist: You did an undergraduate degree in chemistry, ultimately specialising in organic chemistry; do you think inquiry-based science is important for inspiring young people to pursue chemistry?

Professor Andrew Holmes: Inquiry-based learning is important. I was certainly given the opportunity to do my own experiments at school and that inspired me to be a little bit more daring and creative.

Some people give great lectures that include demonstrations - for example, a wonderful man from the UK, Colonel Brian Shaw, used to give public lectures on the way in which explosives work. Shaw would demonstrate how water undergoes a massive expansion in the space it occupies when it turns into steam by suspending a vessel containing water over a Bunsen burner. As he would start talking about a loud bang, the whole tube would blow up as the pressure increased with the heat. Then he would continue with perfect timing talking about imagining being in the vicinity of Krakatoa when a cubic kilometre of water went into the Earth's core and the second vessel would explode. It was tremendously dramatic stuff, and that's what inspires young people.

But you need to protect the audience - there's a fine line between inquiry-based science and being a safe scientist.

It's important that we don't do things that aren't safe, but on the other hand - and I think this is in general in life - people need to be allowed to take a calculated risk.

LLS: You pursued a PhD in London?

AH: Yes. It was the tradition in those days.

I was fortunate enough to get a Shell scholarship, which doesn't exist anymore. Back then a lot of students from Commonwealth countries went to Britain on these PhD scholarships. We were called the Shell scholars; it was a very privileged position to be in.

> "We were working on a frog venom ... one of our synthetic intermediates accidentally turned into a polymer."

I remember being interviewed as part of the final shortlist here in Victoria and the Vice Chancellor of the University of Melbourne at the time, Sir George Paton, leant forward and said 'And where do you plan to study?' and I said 'University College' and he said 'Oxford?' and I said 'No, London', and there was deathly silence because most Shell scholars went to Oxford and Cambridge.

I was going to work with Professor Franz Sondheimer in Cambridge, but the year I was awarded the scholarship I discovered he planned to move to University College London.

He was involved in the discovery of the first female oral contraceptive, which was isolated and made from a material found in the root of the Mexican yam, and helped found the company Syntex, which developed this product. And he became very rich - some people do become rich through doing science!

He and his wife loved theatre and the opera so they moved to London to have a more stimulating cultural life, in addition to his scientific life. We were all in awe of this man who was both a brilliant scientist and very rich. I joined him in London and did a PhD with him.

Professor Sondheimer had moved his research to making molecular analogues of benzene, called annulenes. My PhD was on these molecules, they were quite hard to make but they were quite interesting theoretically.

LLS: How did you end up staying in the UK for more than three decades?

AH: I didn't expect to of course. My wife was also born in Melbourne - but we married in London - and we both thought we would return to Australia.

I did a postdoctoral year in Switzerland working on the synthesis of vitamin B12, which was a very complex molecule by the standards of the 1960s and 1970s. There was an epic contest going on to make the molecule and I was lucky enough to be in the labs in Zurich when it was finally made. There were great celebrations at the time because it was a long and interesting project where lots of new kinds of chemistry were discovered as a by-product.

Eventually I was appointed to a position at Cambridge and stayed for 32 years.

LLS: Was that where your interest in polymer research began?

AH: Having worked in Zurich on trying to make a natural product, B12, I decided I would enter the field of organic natural product synthesis; that is, making molecules that have been isolated from nature whose structure is new.

We were working on a frog venom that was extruded from the skin of Colombian poison arrow frogs; it wasn't that poisonous but it was a really interesting molecule.

One of our synthetic intermediates accidentally turned into a polymer. We obtained some funding through the British Technology Group - a government quango, which was the only way you could exploit inventions in UK universities in the 1970s - to support a PhD student to continue the work.

We also found out that a physicist at Cambridge, Richard Friend, now Sir Richard Friend, was interested in the polyacetylene materials for use in transistors. I made contact with him and he suggested we write a joint grant proposal. He was also interested in another polymer called polyphenylene vinylene or PPV, a more stable version of the polyacetylene conducting polymers but more of a semiconductor than a conductor. It has properties a bit like silicon.

So we agreed to collaborate. I appointed an Australian, Dr Paul Burn, as a postdoc and he spent as much of his time in the physics labs as he did in the chemistry labs.

The whole project went off in a different direction when the PPV that Paul made was tested in Richard's lab to see whether it worked in a transistor - when it was hooked up to a battery it gave out green light. We had discovered electroluminescence in polymers.

Electroluminescence simply means that material gives out light when it's electrically stimulated by injecting charge into a thin film. And that's what an LED is. But these were organic polymer lighting devices, which hadn't been seen before.

LEDs were known, but they're inorganic and made from combinations of elements such as gallium and arsenic and other materials. In fact, this year's physics Nobel Prize was awarded for the discovery of blue LEDs. We had independently made polymers that acted as LEDs and ultimately that work has led to the development of blue polymer LEDs.

Our team accidentally discovered that there were certain types of plastics that did the same thing. This was really exciting as we believed at the beginning that we were the only ones who knew this. Patents were filed and we spent about a year doing unfettered research discovering the scope of this and filing patents left right and centre.

The first paper was published in *Nature* and the citations now must be up around 9000. It's just unbelievable, the fantastic impact that research had.

LLS: It sounds very serendipitous.

AH: Yes, and that's the most important thing! It wouldn't have happened if we hadn't taken the discoveries in various different directions, taking that calculated risk.

That's the most exciting thing to share with people. If you keep your eyes open and a new idea emerges, run with it because it's such a privilege to have that opportunity.

LLS: And is this research now being applied?

AH: It is now, finally.

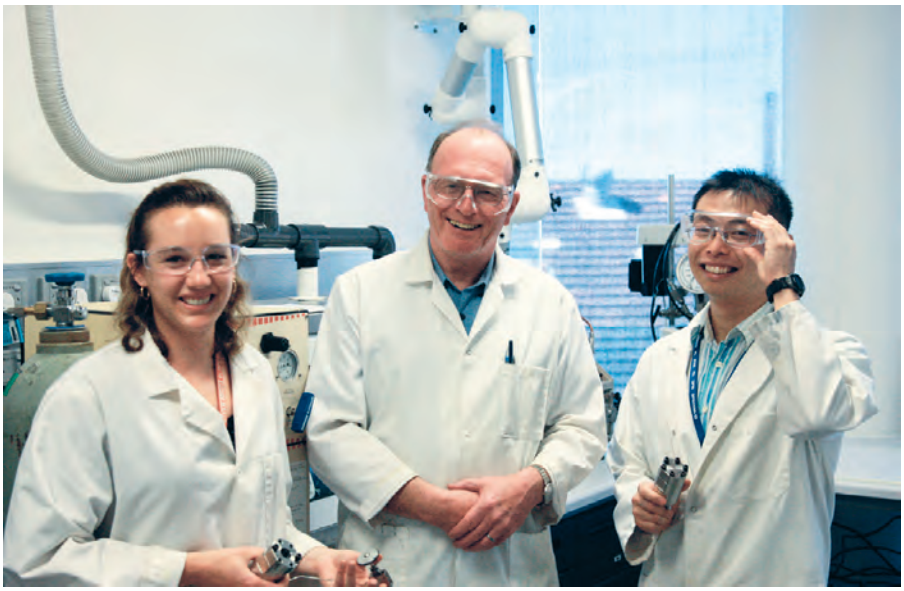
There was a parallel technology using thin films of small molecules that are created by vapour deposition, whereas our polymers are delivered by inkjet printing.

That technology with the small molecules was owned and invented by Kodak, who licensed the technology to Pioneer. The long and short of it is that an array of small dots of red, green and blue emitters can form the basis of the flat screen TV; it is also now in a very famous Korean handheld device - the Samsung Galaxy.

If you take a microscope up to any TV screen you will see the red, green and blue dots if you look closely enough. But the eye doesn't see the dots, it sees the image.

The polymer technology is also emerging in a flat screen television made by another Korean company, LG. It's very close to market now, and the first patent was filed in 1990 - so it shows how long it takes for technology like this to emerge into the marketplace.

Drs Andrew B Holmes and N Obata as postdoctoral researchers, ETH-Zürich (Eschenmoser group) 2002.



Andrew Holmes with colleagues Georgia McCluskey and Wallace Wong in the Bio21 laboratories at the University of Melbourne (photo credit Dooijn Vak).

There are three key applications for the polymer technology in this field of plastic electronics - light emission, electricity generation and transistors.

We're currently working on applications in electricity generation, such as solar cells. If you make a thin film of these materials and they absorb light, they can give out electricity, which is what solar cells do.

We could not have believed this would have happened with organic materials when we thought the preserve of semiconductors was inorganic materials. It's simply a matter of market opportunity now.

The advantage of using thin films of polymer materials on plastic as opposed to the traditional solar cell (silicon on glass) offers the opportunity of making low-cost, large-area flexible solar cells.

LLS: Did you set up a company when you began filing patents?

AH: Yes, and there is a whole family of patents. We founded a company called Cambridge Display Technology, which I think was the first genuine collaboration between physics and chemistry in Cambridge.

In 1989 at Cambridge University we had just two people in the technology transfer office. Although this was probably inadequate, the policy at that time was that the inventors owned the intellectual property, and we got help from a small company that helped file the patents and they got a share of the IP.

The physicists filed the first patent and the chemists came in with the second one and then we persuaded everyone that we had to form a company.

We had a contact in an intellectual property firm in London and rang up for some advice. We were very lucky to receive free IP advice from them for a year. They looked after us in the critical times and took us through to the founding of the company - it was all pro bono, so we were very lucky to have that at the start. That kicked off the company side of things, with the university cooperating and the ownership was generously divided amongst the inventors and the company and the founding investors.

The company still exists. It's been bought by a Japanese company called Sumitomo Chemical but CDT still has its headquarters, research labs, pilot plant and fabrications labs in Cambridge.

What I'm most proud of is that we probably created one hundred jobs in the Cambridge area.

LLS: How does your experience of collaboration between university-based research and industry in the UK compare with that in Australia?

AH: Recently the UK government decided to maintain level funding for the science base despite the global financial crisis - and that's an interesting contrast with Australia.

Britain has also made some really serious practical commitments to support translation of inventions to the marketplace because, they say, it is their future.

I think it's also our future in Australia and that's our biggest concern. If we don't invest in creative research and technology to improve productivity and manufacturing, eventually we won't have anything to sell and we won't progress.

The statistics show that on an OECD scale we are the worst performer on engagement with industry and that's partly because neither party has had the incentive to get together and brief one another - it's a synergistic thing and it does need a very serious commitment to make that happen.

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Some of the things we are hearing from the government at the moment suggest they are going to pay more attention to that, but it really does need sustained commitment - you've got to build up the capacity and then you've got to create the culture. There are people doing this on an individual basis here in Australia, but there are few opportunities.

The research in Australia is outstanding but people are spread rather thinly, so that makes it harder. Networking is important and we've got to encourage that - we are too small to compete in Australia, we've got to collaborate.

LLS: What is you involvement with industry like here in Australia?

AH: It's pretty good, but it's a shadow of the kind of industrial engagement we had in Britain and in Europe. The European Union collaboration was a real eye-opener for me because we had partnerships with all the major European countries.

We have industrial collaborations with the solar cell work we are doing in Australia, printing solar cells on plastic. We've had very good collaborations with a number of companies, including BlueScope Steel, because they would very much like to have integrated roofing with solar cells built into rooftops. Other partners include Innovia Security, the company that prints the base of the polymer bank notes, which arose through our CSIRO links because the CSIRO science that invented the polymer banknote went into this company.

LLS: You took up the role of President of the Australian Academy of Science in May this year. Do you have a goal for your four-year appointment?

AH: It is my ultimate ambition that regular consultation with government becomes a routine arrangement.

The President of the Royal Society said he speaks to the UK Science Minister on a weekly basis, with the Chancellor of the Exchequer (Treasurer) about once a month and the PM once or twice a year. That's an impressive relationship that has been developed in the UK through a strong investment in people relations.

At the academy we have the privilege of being asked by government to carry out policy surveys and exercises, which allows us to inform government and the public with our policy papers. We also meet with ministers, and the opposition, and interact and share ideas with them, but we don't have the level of relationship in science that exists in Britain. I wouldn't say it's existed in Britain for a long time, but in recent years it has been very strong.

One of my goals is to build a similar confidence and trust between the Australian Government and the Australian Academy of Science.

Andrew and Jenny Holmes on the occasion of admission to Honorary Fellowship at University College London, 2012 (photo credit University College London).

LLS: Do you think the government could have a broader approach to supporting science?

AH: I think the government does pay more attention to the researchers in particular areas, such as medical research. They rightly deserve to be heard because they are outstanding researchers. I'd like this to be on a broader basis and we are working on that.

A convincing case has been made to government that a long-term strategy is needed - and it would fit with the idea of a long-term strategy if there was an MRFF. I think everyone would agree, including medical researchers, that medical science is underpinned by the basic physical and biological sciences - you can't get one without the other. So we need a much more holistic view of science strategy. I like to call it investing for the future.

LLS: And that involves attracting more young people to do science?

AH: Yes, certainly. If you create opportunities for young people and inspire them to do science, that will translate into older people who are interested in continuing in the field. It's very important to start with young people; it's where we must invest even more.

We are concerned about our educational performance in the Program for International Student Assessment test - it's a good benchmark. Our performance in mathematics, physics and basic sciences is slipping behind our competitors, particularly in East and South-east Asia. They are getting better and we are not keeping up, and they are our economic competitors, so we need to at least maintain the OECD average.

LLS: What is some of the work the AAS is currently doing?

AH: There are two areas. We're currently promoting opportunities for women to stay in science and to work through all the aspects of what it takes to be a scientist as well as have other things occupying you in the middle of your career. The second is to give early-career researchers the chance to get onto the ladder.

We've produced a couple of really good question and answer series that include basic questions explained in a language to help anyone in the community understand scientific issues. One that has been very popular is on the science of immunisation. We are revising another one at the moment on the science of climate change to bring it into alignment with current thinking because of the recent publication by the Intergovernmental Panel on Climate Change.

The academy also has a couple of educational programs that follow an inquiry-based learning system where children make discoveries by doing experiments under controlled conditions. In the Primary Connections program, children are encouraged to discover things by inquiry and teachers are empowered to teach - even teachers who have never taught science - by careful training and mentoring.

I sat in with a class last year with six- to eight-year-old children and they were looking at mouldy bread under a microscope. They were doing simple but challenging experiments like putting the mouldy bread in the sunlight and seeing whether the mould grew faster. And they were absolutely gung-ho about finding out the answers to these questions.

The academy has been doing this for over 10 years. It has been a very successful program heavily funded by the Australian Government but it's penetrated two-thirds or three-quarters of Australian primary schools. In South Australia it is a mandatory component of the primary program in schools. We have a similar one for early secondary school science students (Science by Doing).

These educational programs are about creating an informed community that has the independent ability to consider scientific information and draw their own conclusions. I think that's important. I'd be very pleased if all our decision-making was made on that basis.

It's a great privilege to have been trained as a scientist. You don't necessarily need to end up practising science, there are many valuable contributions people who have been trained in analytical thinking can make in other aspects of society. So there's a benefit in having science training, just as those who have been trained in philosophy or music, we need that richness of cultural experience to make a civilised society.

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Koala transcriptome revealed

Researchers have sequenced 15,000 genes from the koala, *Phascolarctos cinereus*, taking a significant first step in the characterisation and assembly of the koala genome.

Generated from the genomes of two geographically separated koalas, one male and one female, the work was conducted by Dr Rebecca Johnson from the Australian Museum Research Institute, Professor Peter Timms at Queensland University of Technology and collaborators at the University of New South Wales.

Previously fewer than 100 genes had been identified and the researchers expect the data will provide new insights into some of the unique biological attributes of this iconic Australian species, such as their ability to live entirely on a diet of eucalypt leaves which are indigestible to most other species.

Genes specifically expressed in a range of different tissues including spleen, liver, uterus, kidney, lung, heart, brain, adrenal gland, bone marrow, lymph node, salivary gland, and testes were identified. Of putative protein sequences identified, 72% aligned to at least one sequence in the NCBI protein database, with the best alignments to sequences from other marsupials.

The work will also improve the conservation of koalas by increasing understanding of koala immune responses to diseases that currently threaten many populations, such as the koala retrovirus.

Most koalas living on mainland Australia (95%) are infected with this retrovirus, which is thought to be involved in causing Koala Immune Deficiency Syndrome (KIDS), an AIDS-like syndrome that causes infected koalas to become more susceptible to infectious disease and cancer.

The retrovirus is integrating into the koala genome, and in this research, koala retrovirus transcripts were detected in the transcriptomes of the two animals studied. Both koala genomes had sequences from the A subtype of the virus, but the male koala transcriptome also had sequences more closely related to the B subtype - the first report of a koala retrovirus B-like sequence in a wild population.

The transcriptome is also being used to develop a koala population genetic assay which will enable the genetic diversity of individual koalas and koala populations to be examined.

The study was published, open access, in *BMC Genomics* and the data is searchable at the AMRI website.

AMRI was officially launched by the NSW Minister for the Arts Troy Grant in August this year.

Reversing the decline of mammals in northern Australia

The EcoFire project is leading the way in reducing the area burnt in wildfires and retaining old growth vegetation in an attempt to reverse the decline of native mammals in northern Australia.

Australia's tropical savannas are one of the most fire-prone environments in the world due to the region's long dry season - the savannas make up around 20% of the country's landmass and 75% of the total area burnt each year.

Recent research has implicated predation by feral cats as a major driver of mammal decline, but cat predation may be influenced by other factors such as fire. Fire can also have a direct impact on mammal numbers.

Dr Graeme Gillespie, from the Northern Territory Department of Land Resource Management, leads a research team that is part of the National Environmental Research Program within the Northern Australia Hub - a collaboration that involves more than 100 researchers and various partners.

"The plight of native mammals is a complex problem, and we need evidence to deliver a solution to that problem," Gillespie said in a statement. "Many people start fires without it being part of an overall plan to manage the landscape. We could increase the survival chances of native mammals by managing fire to reduce its frequency, extent and intensity."

Mammals can survive during and after some fires, but their ability to find cover and food, and to reproduce or retain their numbers, can be drastically reduced.

Australian Wildlife Conservancy (AWC) is one partner in the Northern Australia Hub that has been researching fire and fire management. Working with several collaborators, AWC's EcoFire project has halved the area burnt in wildfires and doubled the area of old growth vegetation across a four million-hectare area in the Kimberley.

Research undertaken at AWC's Mornington Wildlife Sanctuary in the Central Kimberley has shown that fire is one threat which allows other factors like predation by feral cats to have a much bigger impact on native mammal populations.

"Mammal mortality is likely to be higher after more intense fires because after an intense fire, extensive burnt ground offers few refuges and they are easily picked off by cats," AWC Chief Scientist Dr Sarah Legge said.

"A key success of EcoFire is its collaboration with Indigenous communities and pastoralists. By involving land managers in the research it helps them to see and manage the problem."

"Fire management protocols need to be evidence-based. They should also include targets that leave large areas unburnt for between three and 10 years, and ongoing monitoring."

Delicate mouse. Photo: Northern Australia Hub.

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New chief executive for CSIRO

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) will have a new chief executive as of January 2015 - international technology innovator Dr Larry Marshall. He will replace outgoing chief executive Dr Megan Clark, who will leave CSIRO at the end of December after six years in the role.

The chair of the CSIRO board, Simon McKeon, described the chief executive role as "probably the most important position in national science administration". He said the organisation conducted a global search and considered more than 70 candidates for the position.

"Dr Marshall combines commercial and scientific credentials with extensive global experience, making him the world-class leader we were seeking for CSIRO," McKeon said.

After receiving his doctorate in physics from Macquarie University, Dr Marshall began his career in the Defence Science and Technology Organisation. He became an inventor, with 20 patents protecting numerous commercial products generating over $200 million in revenue; an entrepreneur, raising over $100 million in funding and creating companies with over $1 billion in market cap; and an investor, with $400 million under management.

Dr Marshall has founded six successful US companies in biotechnology, photonics, telecommunications and semiconductors. He is on the boards of nine companies, chairman of three others and co-chairman of another two. He is also managing director of Southern Cross Venture Partners, an early-stage venture capital firm specialising in creating Australian technology companies and growing them in Asia and the US.

"Dr Marshall has an impeccable record as a scientist, a technology innovator and business leader," McKeon said.

"His wealth of experience in developing and applying science and technology makes him an excellent fit."

Merck buying Sigma-Aldrich for $19.6bn

Merck will spend US$17 billion ($19.59 billion) to buy US-based Sigma-Aldrich, as the world's oldest pharmaceutical company sets a target of becoming a global leader in the broader life sciences industry.

Merck has arranged to acquire 100% of Sigma-Aldrich for $140 per share, a 36% premium to the one-month average trading price prior to the announcement.

Sigma-Aldrich provides research chemicals and biochemicals to the global life science sector. Based in Saint Louis, USA, the company provides a library of over 147,000 chemical products.

The merged company will have combined sales of around €4.7 billion ($6.83 billion) - based on FY13 results - and a supply chain that can support the delivery of more than 300,000 products.

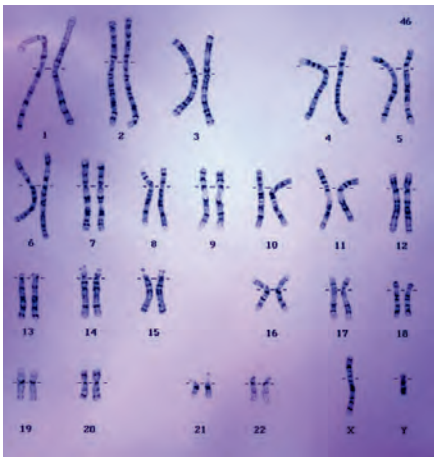
Pending shareholder and regulatory approvals, the transaction is expected to complete in mid-2015.

In a video interview, Merck Chairman Karl-Ludwig Kley said the company aims to use the merger to improve its US presence, expand into Asian countries and deliver services via Sigma-Aldrich's e-commerce platform.

AGRF and Garvan partner on whole human genome sequencing

The Australian Genome Research Facility (AGRF) and the Garvan Institute of Medical Research (Garvan) have announced a collaboration to facilitate Australia's access to whole human genome sequencing.

The partnership will combine AGRF's national genomics infrastructure with the sequencing power of Illumina's HiSeq X Ten platform, located in the Kinghorn Centre for Clinical Genomics at the Garvan Institute, to provide simplified access to the broader community of Australian genomic researchers. The large-scale HiSeq X Ten system is capable of sequencing a whole human genome at a base cost below US$1000.



Designed with the specific purpose of sequencing the three billion bases of the human genome, the platform can sequence more than 350 human genomes per week - the equivalent of 18,000 genomes per year. Following Garvan's purchase of the system in January, executive director Professor John Mattick claimed its acquisition would "underpin a new phase of collaboration between government, industry and other medical research stakeholders".

The partnership with the AGRF may be the first phase of this collaboration. The facility's reputation as a quality genomics service provider with national reach is expected to assist Garvan in servicing more of the nation's biomedical genomics users.

"Providing access to the best suite of relevant technologies is one of AGRF's key remits as a national genomics provider," said AGRF CEO Sue Forrest. "As such, we are excited to be able to partner with the Garvan Institute to offer the capabilities of the HiSeq X Ten to Australia.

For more information on accessing the whole human genome sequencing service through Garvan, contact the AGRF at www.agrf.org.au/campaigns/whgs.

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2014 Ig Nobel Prize Winners announced

The 2014 Ig Nobel Prizes were awarded on 18 September at the 24th First Annual Ig Nobel Prize Ceremony, held at Harvard University's Sanders Theatre. Described by the journal *Nature* as "arguably the highlight of the scientific calendar", the awards for improbable research honour scientific achievements that first make people laugh, then make them think.

This year's Physics Prize was awarded to researchers from Kitasato University, Japan. The team measured the amount of friction between a shoe and a banana skin, and between a banana skin and the floor, when a person steps on a banana skin that's on the floor.

The Neuroscience Prize was meanwhile awarded to a Chinese-Canadian collaboration who attempted to understand what happens in the brains of people who see the face of Jesus in a piece of toast. The researchers suggest that "human face processing has a strong top-down component whereby sensory input with even the slightest suggestion of a face can result in the interpretation of a face".

The winners of the Psychology Prize amassed evidence that people who habitually stay up late are, on average, more self-admiring, manipulative and psychopathic than people who habitually arise early in the morning. The team included Australian Peter K Jonason, from the University of Western Sydney.

The Public Health Prize winners investigated whether it is mentally hazardous for a human being to own a cat. And still on the topic of animals, the Arctic Science Prize winners tested how reindeer react to seeing humans who are disguised as polar bears.

Continuing the animal theme, the winners of the Biology Prize carefully documented that when dogs defecate and urinate, they prefer to align their body axis with Earth's north-south geomagnetic field lines. They weren't the only team to deal in defecation - Spanish researchers won the Nutrition Prize after trawling through baby faeces to obtain bacteria that could both ferment sausages and also pass through the stomach to colonise the gut.

In an unusual use of a scientific instrument, Italian researchers won the Art Prize for measuring the relative pain people suffer while looking at an ugly painting, rather than a pretty painting, while being shot in the hand by a powerful laser beam. Italy additionally received the Economics Prize, for its National Institute of Statistics increasing the official size of its national economy by including revenues from unlawful financial transactions between willing participants, including prostitution, drug sales and smuggling.

Finally, the Medicine Prize was awarded to a US-Indian collaboration which treated uncontrollable nosebleeds by packing the nasal passages with strips of cured pork. The researchers claimed their "nasal tampon … successfully stopped nasal haemorrhage promptly, effectively, and without sequelae".

For more information about this year's awards, visit http://www.improbable.com/ig/2014/.

Turn your smartphone into a cosmic ray detector

Researchers from the University of Wisconsin-Madison (UW-Madison) have developed a smartphone app that can turn Android phones into detectors to capture the light particles created when cosmic rays crash into Earth's atmosphere. The project was led by Justin Vandenbroucke, a UW-Madison assistant professor of physics and researcher at the Wisconsin IceCube Particle Astrophysics Center (WIPAC).

Cosmic rays are energetic subatomic particles, believed to be created in cosmic accelerators like black holes and exploding stars. When the particles crash into the Earth's atmosphere, they create showers of secondary particles called muons. When a muon strikes the semiconductor that underpins a smartphone camera, it liberates an electric charge and creates a signature in pixels that can be logged, stored and analysed.

The smartphone project, known as DECO (Distributed Electronic Cosmic-ray Observatory), includes a data logger and the DECO app. After downloading the app, the user should cover their phone's camera lens with duct tape. The phone can then be placed screen-up just about anywhere - even in a desk drawer, as muons can penetrate matter much like X-rays.

Left running, an idle phone can be set to record an image every couple of seconds. It will then analyse the image and, if enough pixels light up, it gets recorded as a particle event. Particle tracks from both cosmic rays and radioactivity in the environment can be recorded, and events may sometimes be matched to cosmic phenomena detected by more sophisticated observatories. The data logger meanwhile routes event information - time, location and observations - to a central database.

Vandenbroucke said the idea behind the pocket cosmic ray detector is primarily educational. His WIPAC group, with grant support from the national program QuarkNet, plans to engage high-school teachers to develop curricular materials around the use of the detector.

"It would be great to get students and the public interested in gathering data and understanding the particles around them; things they ordinarily don't get a chance to see," Vandenbroucke said. He believes that if enough people use their old smartphones to capture muons, the project could one day evolve into a meaningful citizen science initiative.

To download the data logger and app, visit http://wipac.wisc.edu/learn.

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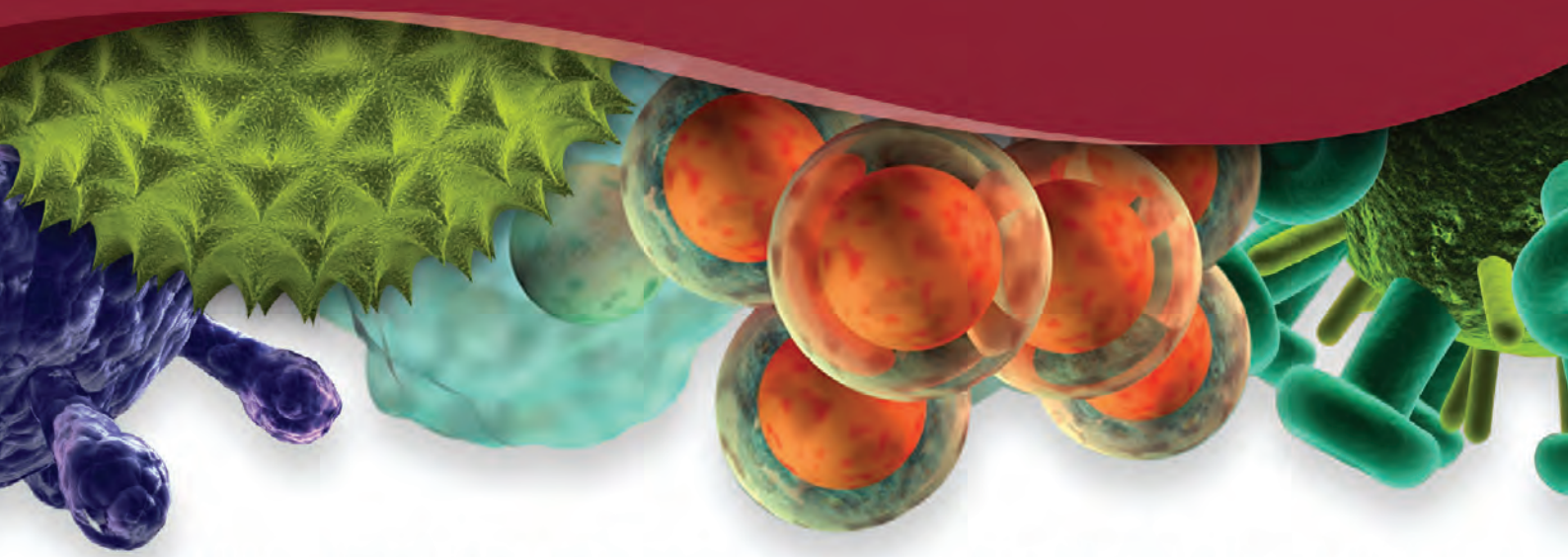

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Full Court confirms isolated DNA is patentable in Australia

D'Arcy v Myriad Genetics Inc [2014] FCAFC 115

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In a unanimous and significant decision, a five-member bench of the Full Court of the Federal Court of Australia (Allsop CJ, Dowsett, Kenny, Bennett and Middleton JJ) has confirmed that a claim covering naturally occurring deoxyribonucleic acid (DNA) or ribonucleic acid (RNA), which has been isolated, can be a "manner of manufacture" and therefore a patentable invention. The Full Court reached a contrary conclusion to the US Supreme Court, which, in relation to the corresponding US patent, held that a naturally occurring DNA segment is a product of nature and not patent eligible merely because it has been isolated. The decision continues a trend in which Australian courts have shown reluctance to exclude inventions in the medical sphere from patentability (on the basis of not being a "manner of manufacture") where Parliament has declined to do so.

In *Cancer Voices Australia v Myriad Genetics Inc* [2013] FCA 65 (**Cancer Voices**), Nicholas J dismissed an application by Cancer Voices Australia and Yvonne D'Arcy to revoke claims 1 to 3 of Australian Patent No. 686004 (the **Patent**) on the ground of lack of "manner of manufacture". The Patent concerns the BRCA1 gene, mutations in which cause a predisposition to breast and ovarian cancer, as well as use of the BRCA1 gene in the diagnosis of predisposition to breast and ovarian cancer.

Ashurst has previously reported on *Cancer Voices* and the US decisions on Myriad Genetics' corresponding US patent in the 12 May 2010, 30 August 2011 and 14 October 2013 editions of Life Sciences Update.

Ms D'Arcy appealed from Nicholas J's decision, and the Full Court has now dismissed the appeal with no order as to costs.

The invention claimed

The appeal before the Full Court focused on claim 1 of the Patent, which is to:

An isolated nucleic acid coding for a mutant or polymorphic BRCA1 polypeptide, said nucleic acid containing in comparison to the BRCA1 polypeptide encoding sequence set forth in SEQ.ID No:1 one or more mutations or polymorphisms selected from the mutations set forth in Tables 12, 12A and 14 and the polymorphisms set forth in Tables 18 and 19.

A number of features of the claim may be observed:

- it is to a compound, an "isolated nucleic acid", ie, tangible material and not genetic information;
- the isolated nucleic acid:- is substantially separated from the other cellular components that naturally accompany native DNA or RNA; and- codes for a mutant or polymorphic protein;
- "SEQ.ID No:1" is a sequence listing for the BRCA1 wild-type (or typical) gene and represents the coding sequence of a nucleic acid, being cDNA (or "complementary DNA" synthesised from a species of RNA known as messenger RNA), which encodes the BRCA1 polypeptide; and
- the "isolated nucleic acid" contains a sequence identified by comparison with tables which record the mutations or polymorphisms as variations in the encoding sequence shown in SEQ.ID No:1.

The issue

The single issue for determination was whether or not the claims to an "isolated nucleic acid" are for a "manner of manufacture", as required by section 18(1)(a) of the *Patents Act 1990* (Cth). In this regard the phrase "manner of manufacture" refers to an artificially created state of affairs whose significance is economic. These principles were set out in *National Research Development Corporation v Commissioner of Patents* (1959) 102 CLR 252, which was applied in this case.

Ms D'Arcy's submissions and the US Supreme Court decision

Ms D'Arcy admitted that the claimed invention has economic significance, but said this was insufficient to make it a "manner of manufacture" and pressed three main points:

- "a human being's DNA is not the thing we patent, unless isolation makes a difference";
- isolation does not make a difference because the resulting product (the isolated nucleic acid) has the same coding as in nature. This is not an "artificial effect" or a sufficiently "artificial effect"; and
- the claims arise out of a discovery of "laws of nature", which are not patentable.

As noted by the Full Court, Ms D'Arcy's submissions were similar to the reasons why the US Supreme Court rejected the claim to isolated nucleic acids in the corresponding US patent in *Association for Molecular Pathology v Myriad Genetics, Inc*, 596 US 12-398 (2013).

The US Supreme Court held that a naturally occurring DNA segment is a product of nature and not patent eligible merely because it has been isolated. The Full Court was unpersuaded by this decision, preferring the reasoning of the majority of the US court below in *Association for Molecular Pathology v United States Patent and Trademark Office and Myriad Genetics, Inc*, 689 F.3d 1903 (2012), which held that the isolated DNA sequences were "markedly different" to native DNA and therefore patent-eligible.

Full Court's decision

In contrast to Ms D'Arcy's and the US Supreme Court's focus on the similarity between isolated and naturally occurring nucleic acid, the Full Court said "the analysis should focus on differences in structure and function effected by the intervention of man and not on the similarities". Consistent with this, in rejecting Ms D'Arcy's submissions, the Full Court found:

- the challenged claims were not to the nucleic acid as it exists in the human body, but the nucleic acid as isolated from the cell;
- there are structural differences, but, more importantly, there are functional differences because of isolation. For example, without manipulation, isolated DNA cannot code for a protein or polypeptide, this being a function that occurs naturally within the cell; and
- while the gene that contains the mutation or polymorphism exists in nature, until it was isolated, it could not be used to identify the mutation or polymorphism. Once isolated, the presence of the mutation or polymorphism that indicates a likelihood of cancer could not be determined without comparison with the tables of the Patent. This reflects a difference between the gene in its natural state and after isolation.

Accordingly, the Full Court decided in favour of Myriad Genetics, holding that the isolated nucleic acid, including cDNA, has resulted in an artificially created state of affairs for economic benefit, ie, a "manner of manufacture".

Conclusion

Like the decision of the primary judge in Cancer Voices, the Full Court's decision no doubt will cause controversy. Not only does it concern technology of particular public concern in the field of cancer research, diagnosis and treatment, but it tilts the balance in favour of patentability of a vast number of Australian patents for isolated gene sequences.

However, it would be difficult to sustain an argument that the decision is authority for the proposition that any isolated nucleic acid is a "manner of manufacture". The isolated nucleic acid of the Patent was defined by specific mutations or polymorphisms that the Patent taught indicated a predisposition to cancer. While the decision is contrary to the US Supreme Court's decision on the corresponding US patent, the Full Court noted that the Australian Parliament had considered and chosen not to exclude gene sequences from patentability.

Ms D'Arcy has 28 days from 5 September 2014 within which to file a special leave application to the High Court of Australia. If the High Court hears the appeal, dismissal would not be surprising, particularly given the importance recently accorded by the High Court in *Apotex Pty Ltd v Sanofi-Aventis Australia Pty Ltd* (2013) 304 ALR 1 (reported in the 9 December 2013 Life Sciences Alert) to the circumstance that Parliament had not excluded methods of medical treatment from patentability. It appears that substantive change to the patent eligibility of gene sequences in Australia in the near future, if it is to come at all, will come from Parliament and not the judiciary.

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Microplate analyser

The Micro Plate Read is a user-friendly microplate analyser which is designed to measure and interpret in-vitro enzyme immunoassay results. The device can read an entire plate within seconds.

The reader can take both flat and round bottom plates. It uses 405, 450, 492 and 630 nm filters, as well as the option for two extras.

The compact, lightweight reader has a small footprint on the lab's benchtop. Results can be recorded on the reader itself, exported via the built-in thermal printer or sent to a PC via USB or RS232 connection.

Australasian Medical & Scientific Ltd
www.amsl.com.au

System for understanding biomolecular interactions using ITC

Isothermal titration calorimetry (ITC) enables label-free measurement of binding events by measuring the heat released or absorbed during biochemical binding. Binding affinity (KD), stoichiometry (n), enthalpy (ΔH) and entropy (ΔS) can all be measured to provide deeper insights into structure-function relationships and the mechanisms of binding.

Requiring no assay development, the MicroCal iTC200 provides results quickly and is a suitable tool for any research laboratory studying biomolecular interactions. High sensitivity, using as little as 10 μg of protein, provides good signal-to-noise to generate high-quality data over a wide range of affinities, from weak to tight binders. Integrated with user-friendly software, operators are guided for fast and accurate analysis. A baseline-fitting algorithm eliminates the need for tedious post-run manual manipulation.

Applications range from drug discovery and design for characterising bio-molecular interactions to fundamental research such as the understanding and regulation of signal transduction pathways. The types of interactions that can be studied are not limited to proteins and there are numerous references in the literature where ITC has been used to understand how nucleic acids and lipids, as well as proteins, function in biological systems.

The product features no labelling, no immobilisation and no molecular weight limitations. It can measure millimolar to nanomolar affinities and nanomolar to picomolar disassociation constants. It is upgradeable to the fully automated MicroCal Auto-iTC200 system.

ATA Scientific Pty Ltd
www.atascientific.com.au

Flow cytometers

Merck Millipore microcapillary flow cytometry systems are said to be simpler to operate than traditional sheath fluid-based instruments and easier to maintain. They utilise small-sample volumes, generate minimal waste and have low operating costs. As a result, guava easyCyte flow cytometers are amenable to on-demand use in the laboratory environment and help scientists achieve insightful cellular analysis.

The flow cytometry systems are easy to use and deliver complete and comprehensive cell analysis right on the benchtop. The culmination of over a decade of flow cytometry expertise, the instruments are claimed to consume less sample, generate less waste and be easier to use and maintain than traditional flow cytometers, all while providing good analytical power. Single blue (488 nm), dual blue and red (642 nm), or triple blue, red and violet (405 nm) excitation lasers provide up to 12 simultaneous detection parameters, including 10 fluorescent colours, plus forward and side scatter for size and granularity determination.

The range also meets the user's sample throughput needs by offering both single- and multi-sample processing. The guava easyCyte HT instruments provide high-throughput analysis with a robotic sample tray that automatically handles a 96-well microplate and up to 10 sample tubes. The guava easyCyte system meanwhile enables single-sample processing.

Merck Pty Limited
www.merckmillipore.com

Sealing film

UltraFlux RT is a clear polyolefin film suitable for real time-PCR. Its premium materials are claimed to ensure high quality and clarity.

The film only sticks to the surface of the plate when pressed down onto it, so it feels non-tacky when the user handles the film. Once pressed onto the plate, the microencapsulated beads of silicone provide a protective seal. No sticky residue is left to interfere with the results.

A free applicator paddle helps ensure a good seal each time.

Interpath Services Pty Ltd
www.interpath.com.au

NGS workstation for LC-MSMS IVD kit

Tecan and RECIPE Chemicals and Instruments have announced a co-marketing agreement for the automation of LC-MSMS IVD kits.

Tecan's flexible Freedom EVO platform offers walkaway automation of the RECIPE ClinMass LC-MSMS Complete Kits for the analysis of vitamin D2/D3 and immunosuppressants. The automated process is claimed to eliminate the potential for manual handling errors and increase the speed of sample preparation three-fold compared to manual protocols, improving turnaround times while enhancing reproducibility, traceability and sample security.

Tecan Australia
www.tecan.com.au

Plano-convex lenses

Edmund Optics introduces TechSpec Calcium Fluoride Plano-Convex (PCX) Lenses. The lenses are suitable for use in demanding applications that require good performance from the ultraviolet (UV) through the mid-wave infrared (MWIR) spectra.

Featuring a low index of refraction, high laser damage threshold and low axial and radial-stress birefringence, the lenses are suitable for use with Excimer lasers or for integration into IR systems. The lenses, manufactured using a vacuum-grade UV substrate, offer greater than 90% transmission from 193 nm to 7 μm.

Calcium fluoride is characterised by its low solubility and is said to offer better hardness in comparison to other fluoride-based substrates. This makes the lenses able to withstand harsh environments and exposure to the elements. They are available in 12.5, 25 and 50 mm diameters.

The uncoated lenses feature a positive focal length, ranging from 18 to 150 mm, and have one flat and one convex surface. They are RoHS compliant.

Edmund Optics Singapore Pte Ltd
www.edmundoptics.com

Pre-packed columns

WR Grace & Co has introduced ProVance prepacked Protein A columns for purification of biologic drugs, specifically monoclonal antibodies (mAbs). The columns bring together Protein A resin and a convenient prepacked column format designed specifically for facilities sites that have moved to single-use manufacturing methodologies.

The portfolio of disposable columns comes prepacked with a silica-based Protein A resin claimed to have a higher capacity than alternative technology used for mAb purification. Biopharmaceutical users are said to have confirmed 40 to 60% total operational cost reduction with the columns by eliminating time-consuming cleaning and packing steps and achieving increased efficiency. The prepacked disposable columns further improve biopharmaceutical productivity by lowering the risk of contamination and accelerating time to market.

Grace Davison Discovery Sciences
www.discoverysciences.com/au

Modular laboratory workspace

The Modulab System 6000, from Westlab, is a modular, prefabricated system that offers a high-quality and flexible laboratory workspace for institutions, universities and industrial laboratories.

The modules are available with PC2 compliance and are able to be customised in view of satisfying specific requirements. Detachable bench modules and cabinet modules on wheels allow the system to be custom configured and keep laboratory space flexible.

The system provides a 100% steel body which is long-lasting in harsh environments; a modular reconfigurable structure; and a Chemtemp extreme benchtop resistant to high temperature and chemicals. Easy to specify and ensured to fit the user's laboratory space, the system is said to save 80% installation time.

Westlab provides clients with a free design consultancy service, taking them from inception to completion with in-house 3D photorealistic and schematic imaging capabilities. The company's design consultants will ensure the user's facility is filtered through the latest standards available, whether it be an education, medical or analytical laboratory facility.

Westlab Supplies
www.westlab.com.au

Hotplate stirrers

Stuart has expanded its range of Undergrad hotplate stirrers with two digital models. In order to deliver high levels of control and accuracy, the models include an LED display with an exact, continuous readout of the surface temperature. Combined with the existing features of the hotplate range, these additions mean researchers have even greater control over their experiments and processes.

The hotplate stirrers come in two materials - ceramic and ceramic-coated metal. Both employ the features of the existing range, including minimal storage and footprint, with a recess underneath that accommodates a retort stand. This reduces the time spent assembling apparatus. In addition, an independent hot light clearly shows when instrument temperature is over 50°C, even when the unit is unplugged.

LabFriend
www.labfriend.com.au

AppNotes

Temperature monitoring of frozen embryos, sperm and ova

Infertility is a growing problem, not only in Australia, but around the world.

According to IVF Australia, 15% of couples of reproductive age are affected by infertility because of either genetic, medical or surgical reasons where the cause remains unknown. Fortunately, technology has improved significantly in recent years and has allowed in-vitro fertilisation (IVF) to become an efficient way of conceiving a baby.

IVF is basically the process where an egg is fertilised by sperm outside the body. Once this has taken place and the egg is fertilised, it becomes an embryo, and can be grown in culture for up to six days and then transferred into the woman's uterus. If successful, this should result in a pregnancy for the couple.

The success rate of this process is increasing as well. Nine in 10 (90%) patients are pregnant within three cycles and more than 40% after just one cycle. This is higher than when the initial technology was introduced more than 30 years ago.

One of the leading companies in this field is IVF Australia. With over 34 fertility specialists across NSW, the IVF and pathology company boasts the first IVF baby conceived and born in the state back in 1983.

However, one of the main responsibilities as embryo culture methods get better is the freezing of eggs, sperm and embryos, and the care and management of these frozen eggs, embryos and sperm for patients. Most of the samples are irreplaceable and any loss will be a tragedy for the couple involved.

IVF Australia's Scientific Director, Dr Simon Cooke, is responsible for all the NSW laboratories on behalf of their patients, which includes six embryo labs, nine sperm labs and 85 liquid nitrogen (LN) tanks.

All freezing requires samples to be stored at -196°C and Dr Cooke said specialists at "IVF clinics have to manually check the depth of the liquid nitrogen, and but most laboratories have no electronic monitoring devices on their liquid nitrogen tanks, and no knowledge of the exact temperature on the inside of the tanks at all stages of storage, especially on the very rare occasions if there is a problem with one of the tanks".

However, with the introduction of Testo's automated temperature monitoring system - Saveris - this process has become a lot easier.

"All tanks are now electronically monitored, and we can set alarm limits that have defined criteria, based on the exact temperatures as monitored inside the tanks, where the samples are stored. Saveris also monitors the software and hardware related to the tank," Dr Cooke explained.

The Saveris system can measure temperatures from -200°C up to 1760°C, as well as humidity.

Dr Cooke said he was recently able to check the real-time LN tank temperatures using his mobile phone, all the way from a New Zealand ski field.

"Saveris is a wireless system which is a huge advantage to us - it means there are no cables and it's much safer for staff around the tanks. The software also tells you about the integrity of the hardware related to the tank monitoring," he stated.

"Saveris is a very efficient and worthwhile system. Patients are placing a huge amount of trust in us to look after their embryos and sperm. It's a small price to pay for the quality control of our liquid nitrogen tanks."

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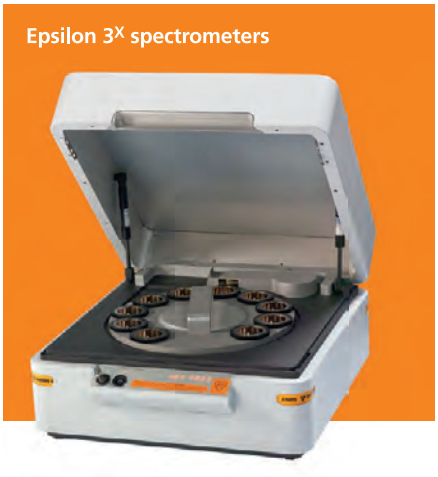




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Capella Science
www.capellascience.com.au

Ancient roots of the mammalian immune response

An unsuspected link between the mammalian immune system and the communication systems of simpler organisms such as bacteria has been uncovered.

Scientists were hoping to identify activating molecules for a rare but crucial subset of immune system cells that help rally other white blood cells to fight infection when they made the discovery.

The findings could lead to novel therapeutic approaches for diseases such as type 1 diabetes that are the result of immune system overactivity, as well as new ways to boost the effectiveness of vaccines, according to study leader Luc Teyton, a professor in The Scripps Research Institute's Department of Immunology and Microbial Science.

A bridge

When a virus, bacteria or foreign substance invades the body, specialised cells known as dendritic cells present in the skin and other organs capture the trespassers and convert them into smaller pieces called antigens that they then display on their cell surfaces. White blood cells known as T and B cells recognise the antigens to launch very specific attacks on the invaders.

Dendritic cells also activate a specialised population of T cells known as type 1 diabetes (NKT) cells. Once activated, NKT cells can commandeer the functions of dendritic cells to make them more effective and also recruit and coordinate the responses of T- and B-type cells.

"Because of their dual functions, NKT cells are a bridge between the body's innate immunity, which is characterised by rapid but less specific responses to pathogens, and adaptive or acquired immunity, which is composed of specialised white blood cells that can remember past invaders," Teyton said.

Previous studies indicated that NKT cells are activated by molecules known as glycolipids that dendritic cells produce and then display on their outer surfaces. It was widely assumed that the activating molecules were a class of glycolipids known as β-glycosylceramides, an important component of nervous system cells.

However, this hypothesis had not been thoroughly examined, in part because there is no chemical test currently available to distinguish between two forms of the molecule that have slightly different configurations - β-glycosylceramide and α-glycosylceramide. In addition, when scientists attempt to create either form synthetically for testing, there is always the possibility of small contamination of one by the other.

"When you're making glycolipids, there is no completely faithful way of controlling the form that you're making," Teyton said. "You're favouring the making of one, but you cannot say for sure that you don't have a small amount of the other form."

A surprising result

In their new study, Teyton and his colleagues, who included scientists from Brigham Young University, the La Jolla Institute for Allergy & Immunology and the University of Chicago, abandoned the chemical approach altogether. Instead, they combined a series of biochemical and biological assays to create a test that was sensitive enough to distinguish between the two different forms of glycolipids.

"Biological assays are exquisitely sensitive to low amounts of otherwise unmeasurable molecules," said study first author Lisa Kain, a research technician in Teyton's lab.

The scientists used custom antibodies to identify and eliminate α-glycosylceramides from their test batches. When the team was confident that their test batch contained only beta forms of the glycolipid, they tested it on NKT cells gathered from mice. To their surprise, however, nothing happened. Contrary to the conventional wisdom, the β-glycosylceramides failed to activate the NKT cells.

"We were very sceptical about the early results," Teyton said. "We thought we had used the wrong antibody."

Next, the team combined enzymes designed to digest molecular linkages found only on β-glycosylceramides with mice NKT cells inside test tubes. Surprisingly, the NKT cells were still being activated.

Finally, when the team used antibodies to disable α-glycosylceramides inside live mice, not only did the NKT cells fail to activate, they disappeared altogether from organs such as the thymus, where NKT cells are produced.

These multiple lines of evidence strongly indicated that it was the alpha form of the glycolipids that were the triggers for NKT cells. "What we thought was the contaminant turned out to be the activating molecule we were looking for," Teyton said.

New therapies

The results were surprising for another reason. Until that moment, scientists did not think mammalian cells were capable of producing alpha forms of the glycolipids. The molecules were thought to exist only in bacteria and other simple organisms, which use them primarily as a means of communicating with one another. The findings thus suggest that the roots of a crucial part of the mammalian immune response are even more ancient than previously thought.

"Nobody expected this," Teyton said. "It's like discovering that all languages share a common origin."

Now that scientists know that α-glycosylceramides are made by our own body and activate NKT cells, they might be able to exploit them to create new therapies. For example, Teyton said, researchers could use enzymes to reduce α-glycosylceramide levels in order to suppress an overactive immune response, which happens with diseases such as type 1 diabetes. Or they could combine the molecules with antigens to create vaccines that elicit a faster and more efficient immune response.

"This opens up an avenue of new therapeutic approaches that we've never even thought about," Teyton said.

In addition to Teyton and Kain, authors of the new study 'The identification of the endogenous ligands of Natural Killer T cells reveals the presence of mammalian α-linked glycosylceramides', which has been published in the journal *Immunity*, include Bill Webb, Marie Holt, Anne Constanzo, Kevin Self, Anais Teyton and Chris Everett of TSRI; Brian L Anderson, Shenglou Deng and Paul B Savage of Brigham Young University; Mitchell Kronenberg, Dirk M Zajonc and Meng Zhao of La Jolla Institute for Allergy & Immunology; and Albert Bendelac of University of Chicago.

what's new

Microcystin reference standards for contamination monitoring

Marine toxins are a potentially deadly and growing worldwide problem as warm water temperatures and farmland run-off combine to create optimal conditions for large algae blooms. Cyanobacteria (also known as blue-green algae) secrete toxins that have been linked to symptoms ranging from skin irritation, nausea and headaches to liver damage, neurotoxic effects and even cancer.

Enzo Life Sciences offers a complete portfolio of products for water testing, including high-purity microcystin analytical reference standards (≥99%) and numerous microcystin analogues. The products have been widely cited in over 50 publications.

The company's water toxins detection products include Natural Marine Toxins, Analytical Reference Standards, Microcystins (Adda specific) ELISA Kit and Hepatotox Set 1.

United Bioresearch Products Pty Ltd
www.unitedbioresearch.com.au

Pipette workstation

By properly storing micropipettes, users are able to prevent damage and extend their life span. Socorex offers the pipette workstation Twister Universal 336, adapted to any laboratory configuration.

The product provides storage space for six pipettes of most brands. Its soft 360° rotation enables quick instrument selection, each pipette being easy to fetch. Made of few parts, the pipette stand is simple to disassemble and reassemble for cleaning.

There is a selection of seven translucent colours to choose from. Discs are interchangeable, enabling various colour combinations.

LabFriend
www.labfriend.com.au

BioResearch

Lonza

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Orbitrap-based mass spectrometer

Laboratories performing food and environmental testing, clinical research, forensic toxicology, pharmaceutical/biopharmaceutical measurements and other applied analyses can now benefit from the performance of high-resolution accurate-mass (HRAM) Orbitrap mass spectrometry using an instrument designed for cost-per-sample-sensitive workflows.

The Thermo Scientific Q Exactive Focus LC-MS/MS is designed to make the qualitative and quantitative power of Orbitrap-based instruments available to users who use quadrupole time-of-flight (Q-TOF) mass spectrometry or other technologies. Besides comparable quantitative data for frequently detected compounds, it provides a complementary screen of many other compounds from the same injection.

The product combines high-performance quadrupole precursor ion selection with an HRAM Orbitrap mass analyser, providing good mass accuracy, sensitivity and fast polarity switching. This has been shown to selectively and accurately quantify and confirm analytes with comparable sensitivity to triple quadrupole instruments.

Full scan confirmation mode and parallel reaction monitoring (PRM) are designed for targeted screening combined with reproducible quantitation results. Data-independent acquisition (DIA) provides qualitative coverage for screening unknowns with supporting quantitative data for many of the unknowns identified.

Thermo Fisher Scientific
www.thermofisher.com.au

Balance line

Mettler Toledo's improved XS balance line includes analytical and precision balances as well as a dual-range microbalance. Ergonomic design details mean users no longer need to suffer the stresses and strains from working for long periods in front of the balance.

Small platform precision balances feature the SmartPan weighing pan, which is said to demonstrate up to twice as fast stabilisation times with results repeatability improved up to two-fold, even in the turbulent weighing conditions of a fume cupboard. Minimum weight can be reduced, which is particularly useful when working with expensive or toxic substances. SmartPan dismantles easily; the built-in tray underneath keeps spilled substances contained for safe disposal and easy cleaning. Cleaning is more efficient and users are protected against exposure to hazardous chemicals.

The terminal features an improved user interface for ease of operation. Shortcuts can be set up on the main screen for direct access to everyday tasks. At up to 16 mm high, the large figures on the display are bright and clear to read.

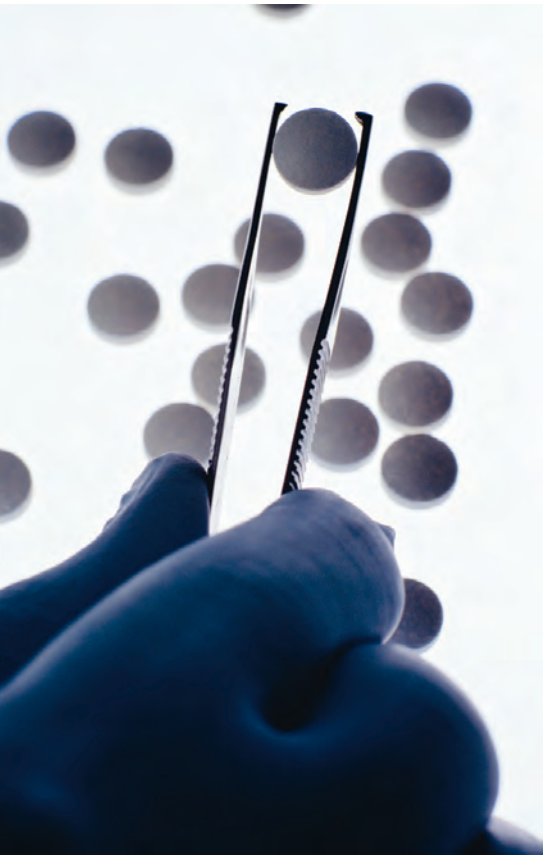
Mettler Toledo
www.mt.com

Slow-axis collimators

Edmund Optics introduces Slow Axis Collimators. They consist of a monolithic array of cylindrical lenses that are designed to collimate the individual emitters of a laser bar.

The collimators feature a numerical aperture of 0.05, surface accuracy of λ/4 and low curvature deviation for increased collimation. They also feature a standard AR coating for 790-990 nm and provide greater than 99% transmission to provide high performance with minimal loss of light. To meet the full range of user collimation needs, the product may be used with Fast Axis Collimators to create custom collimation combinations that provide a wide range of solutions.

Edmund Optics Singapore Pte Ltd
www.edmundoptics.com



All chemists are invited to the RACI National Congress

The Royal Australian Chemical Institute National Congress, to be held in Adelaide from 7-12 December, will be the largest gathering of Australian chemists since 2005 and everyone is welcome. Over 100 plenary, keynote and invited speakers have been drawn from around the world and represent some of the most important work in the chemical community.

Well over 850 abstracts have been received and represent work in many important areas of chemistry as well as cross-disciplinary activities. The meeting will provide a great environment to meet colleagues, discuss current trends and explore new opportunities. There will also be a significant exhibition showing the latest equipment and technology.

RACI 2014 will be held at the multi award-winning Adelaide Convention Centre, on the waterfront of the River Torrens near the heart of the city.

Adelaide is a picturesque coastal city that's easy to get to, easy to get around, easy on the pocket and 'green'. The convention centre offers first-class facilities to delegates, partners and visitors, and is a short walk from accommodation, restaurants and the central business district of Adelaide.

Adelaide is widely recognised as the 20-minute city. The ease of access and stress-free travel is acknowledged by organisers and delegates alike. Where else can you arrive at the international airport, be checked into your 5-star hotel within 20 minutes and then walk to the multiple award-winning convention centre?

To find out more about the RACI Congress or to register to attend, visit www.racicongress.com.

Royal Australian Chemical Institute
National Congress
7-12 December 2014
Adelaide Convention Centre
www.racicongress.com

NGS workstation

Tecan has launched the Freedom EVO NGS workstation to simplify next-generation sequencing (NGS) sample preparation and PCR set-up. Offering user-friendly, walkaway automation of library preparation at the touch of a button, it eliminates the need for extensive manual processing.

NGS is a fast-growing application in genomics, yet many sample preparation protocols can be labour-intensive and time-consuming. The workstation has been designed to offer robust and reliable automation - including library preparation, quantification, qPCR set-up, normalisation, pooling and capture - even for inexperienced users. The preconfigured system includes all the modules required for precise set-up of NGS sequencing libraries, reducing hands-on time and increasing productivity for NGS applications.

The compact system offers one-touch protocol selection and step-by-step user instructions via Tecan's intuitive TouchTools graphical interface. It is supplied with ready-to-run protocols.

Tecan Australia
www.tecan.com.au

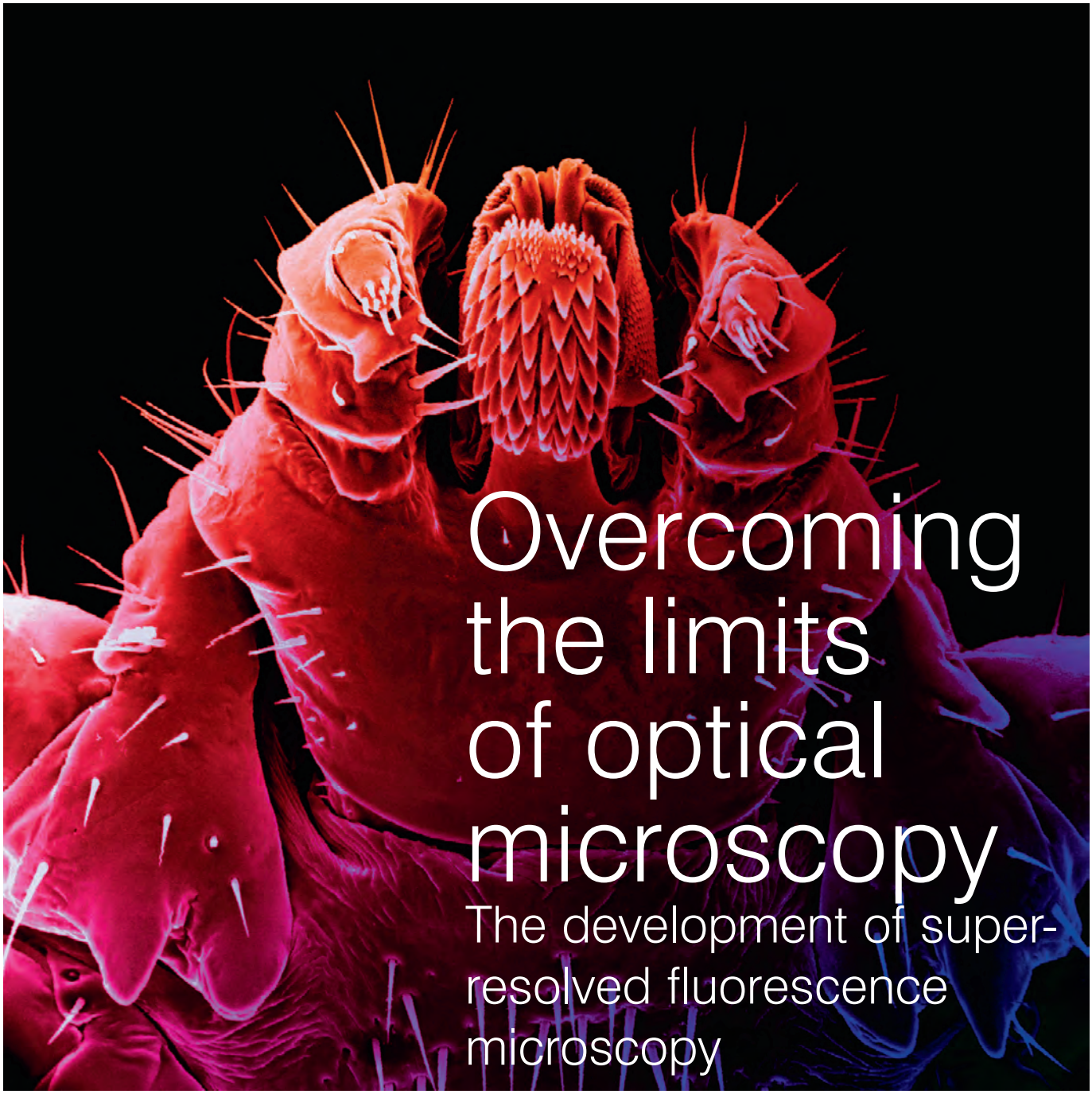
Software for LC/MS/MS data

AB SCIEX MasterView Software simplifies compound identification, quantitation and data review from complex mass spec data files. It enables laboratories to master the speed, power and accuracy offered by LC/MS/MS technology.

Mass spectrometers - especially high-resolution, accurate mass instruments - produce a significant amount of complex data. Turning this data into answers can be a big challenge. The software enables users to identify unknown compounds with greater confidence, using integrated library searching capabilities, formula finder and fragmentation prediction tools to aid in true unknown structural elucidation.

The product integrates both targeted and non-targeted data processing. Easy to learn and operate for scientists at all levels of expertise, it makes data review fast and straightforward with automated visual status indicators. The product links to ChemSpider and library database searching for confident identification of unknowns.

AB SCIEX Australia Pty Ltd
www.absciex.com



Overcoming the limits of optical microscopy

The development of super-resolved fluorescence microscopy

When scientists in the 17th century studied living organisms under an optical microscope for the first time, a new world opened up before their eyes. This was the birth of microbiology, and ever since, the optical microscope has been one of the most important tools in the life-sciences toolbox. However, optical microscopy was limited by a physical restriction as to what size structures it was possible to resolve.

In 1873, the microscopist Ernst Abbe published an equation demonstrating how microscope resolution is limited by, among other things, the wavelength of the light. For the greater part of the 20th century, this led scientists to believe that they would never be able to observe things smaller than roughly half the wavelength of light, ie, 0.2 µm. This meant that while scientists could distinguish whole cells and some organelles, they would be unable to resolve things as small as a normal-sized virus or single proteins, or to follow the interaction between individual protein molecules in the cell.

But Eric Betzig, Stefan W Hell and William E Moerner have found ways to circumvent Abbe's limit. The equation still holds but, using molecular fluorescence, Betzig, Hell and Moerner independently have overcome the limitation and have taken optical microscopy into a new dimension. Theoretically there is no longer any structure too small to be studied and the optical microscope can now peer into the nanoworld.

How Abbe's limit was circumvented

Stimulated emission depletion microscopy

Stimulated emission depletion (STED) microscopy was developed by Stefan Hell in 2000. Here, two laser beams are utilised; one stimulates fluorescent molecules to

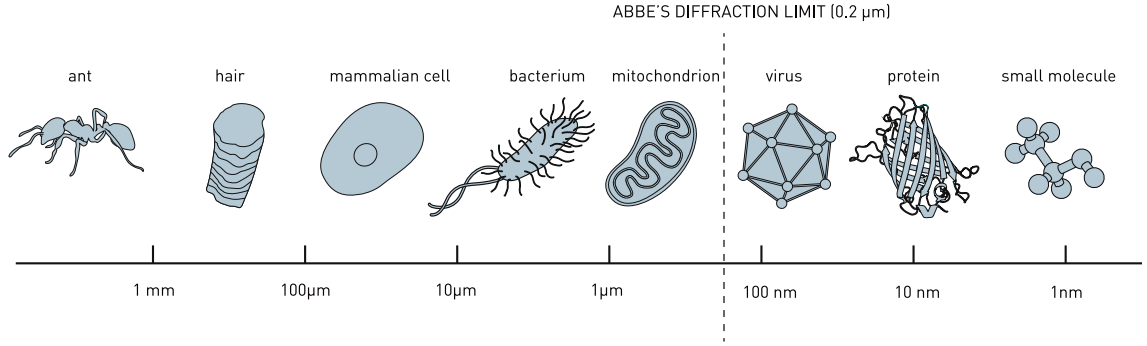


Figure 1: At the end of the 19th century, Ernst Abbe defined the limit for optical microscope resolution to roughly half the wavelength of light, about 0.2 μm.

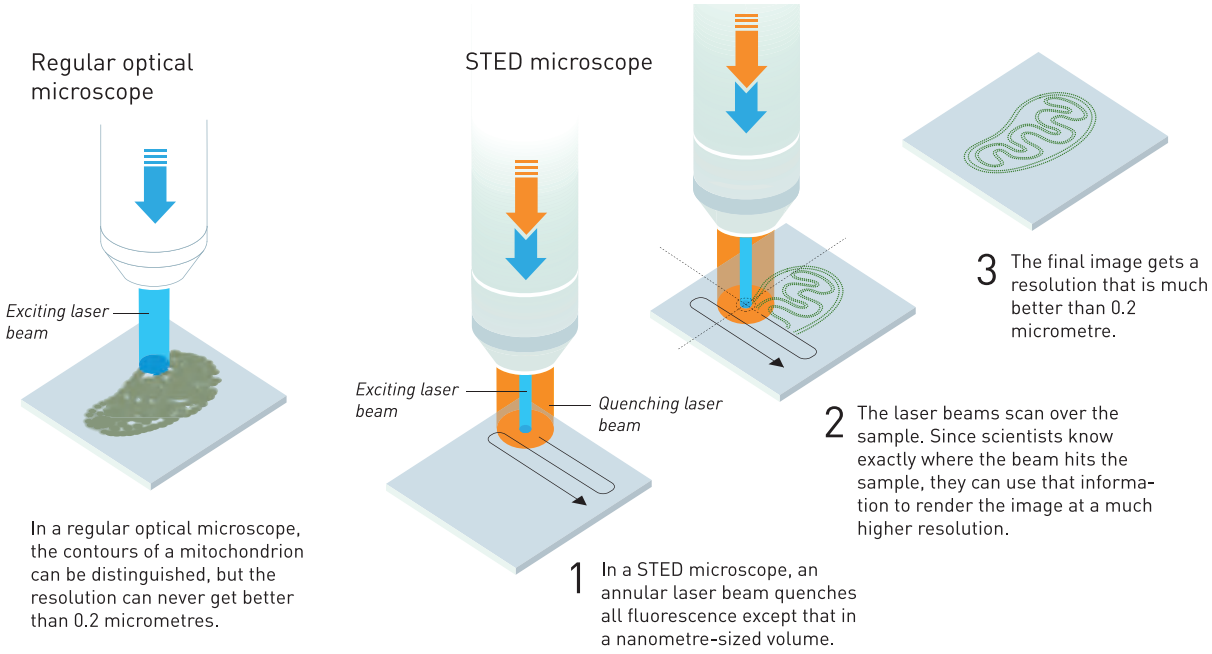


Figure 2: The principle of STED microscopy.

glow, another cancels out all fluorescence except for that in a nanometre-sized volume. Scanning over the sample, nanometre for nanometre, yields an image with a resolution better than Abbe's stipulated limit.

Hell was convinced that there had to be a way of circumventing Abbe's diffraction limit, and when he read the words "stimulated emission" in the book on quantum optics, a new line of thought took shape in his mind.

Fluorescence microscopy is a technique where fluorescent molecules are used to image parts of the cell. For instance, they can use fluorescent antibodies that couple specifically to cellular DNA. Scientists excite the antibodies with a brief light pulse, making them glow for a short while. If the antibodies couple to DNA they will radiate from the centre of the cell, where DNA is packed inside the cell nucleus. In this manner, scientists can see where a certain molecule is located. But they had only been able to locate clusters of molecules, such as entangled strands of DNA. The resolution was too low to discern individual DNA strings.

When Stefan Hell read about stimulated emission, he realised that it should be possible to devise a kind of nano-flashlight that could sweep along the sample, a nanometre at a time. By using stimulated emission, scientists can quench fluorescent molecules. They direct a laser beam at the molecules that immediately lose their energy and become dark. In 1994, Stefan Hell published an article outlining his ideas. In the proposed method, so-called STED, a light pulse excites all the fluorescent molecules, while another light pulse quenches fluorescence from all molecules except those in a nanometre-sized volume in the middle (Figure 2). Only this volume is then registered. By sweeping along the sample and continuously measuring light levels, it is possible to get a comprehensive image. The smaller the volume allowed to fluoresce at a single moment, the higher the resolution of the final image. Hence, there is, in principle, no longer any limit to the resolution of optical microscopes.

Developing the first nano-flashlight in Germany, Stefan Hell's theoretical article did not create any immediate commotion, but was interesting enough for Stefan Hell to be offered a position at the Max Planck Institute for Biophysical Chemistry in Göttingen. In the following years he brought his ideas to fruition; he developed a STED microscope. In 2000 he was

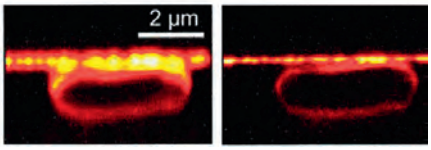


Figure 3: One of the first images taken by Stefan Hell using a STED microscope. To the left, an *E. coli* bacterium imaged using conventional microscopy; to the right, the same bacterium imaged using STED. The resolution of the STED image is three times better. Image from Proc. Natl. Acad. Sci. USA 97: 8206-8210.

able to demonstrate that his ideas actually work in practice, by, among other things, imaging an *E. coli* bacterium at a resolution never before achieved in an optical microscope.

Detecting a single fluorescent molecule

In most chemical methods, for instance measuring absorption and fluorescence, scientists study millions of molecules simultaneously. The results of such experiments represent a kind of typical, average molecule. Scientists have had to accept this since nothing else has been possible, but for a long time they dreamt of measuring single molecules, because the richer and more detailed the knowledge, the greater the possibility to understand, for instance, how diseases develop.

Therefore, in 1989, when W E Moerner was able to measure the light absorption of a single molecule, it was a pivotal achievement. At the time he was working at the IBM research centre in San Jose, California.

Eight years later Moerner took the next step towards single-molecule microscopy, building on the previously Nobel Prize-awarded discovery of the green fluorescent protein (GFP).

Moerner discovered that the fluorescence of one variant of GFP could be turned on and off at will. When he excited the protein with light of wavelength 488 nanometres (nm), the protein began to fluoresce, but after a while it faded. Regardless of the amount of light he then directed at the protein, the fluorescence was dead. It turned out, however, that light of wavelength 405 nm could bring the protein back to life again. When the protein was reactivated, it once again fluoresced at 488 nm.

Moerner dispersed these excitable proteins in a gel, so that the distance between each individual protein was greater than Abbe's diffraction limit of 0.2 µm. Since they were sparsely scattered, a regular optical microscope could discern the glow from individual molecules - they were like tiny lamps with switches. The results were published in the scientific journal *Nature* in 1997.

By this discovery Moerner demonstrated that it is possible to optically control fluorescence of single molecules. This solved a problem that Eric Betzig had formulated two years earlier.

Just like Stefan Hell, Eric Betzig was obsessed with the idea of bypassing Abbe's diffraction limit. In the beginning of the 1990s he was working on a new kind of optical microscopy called near-field microscopy at the Bell Laboratories. In near-field microscopy the light ray is emitted from an extremely

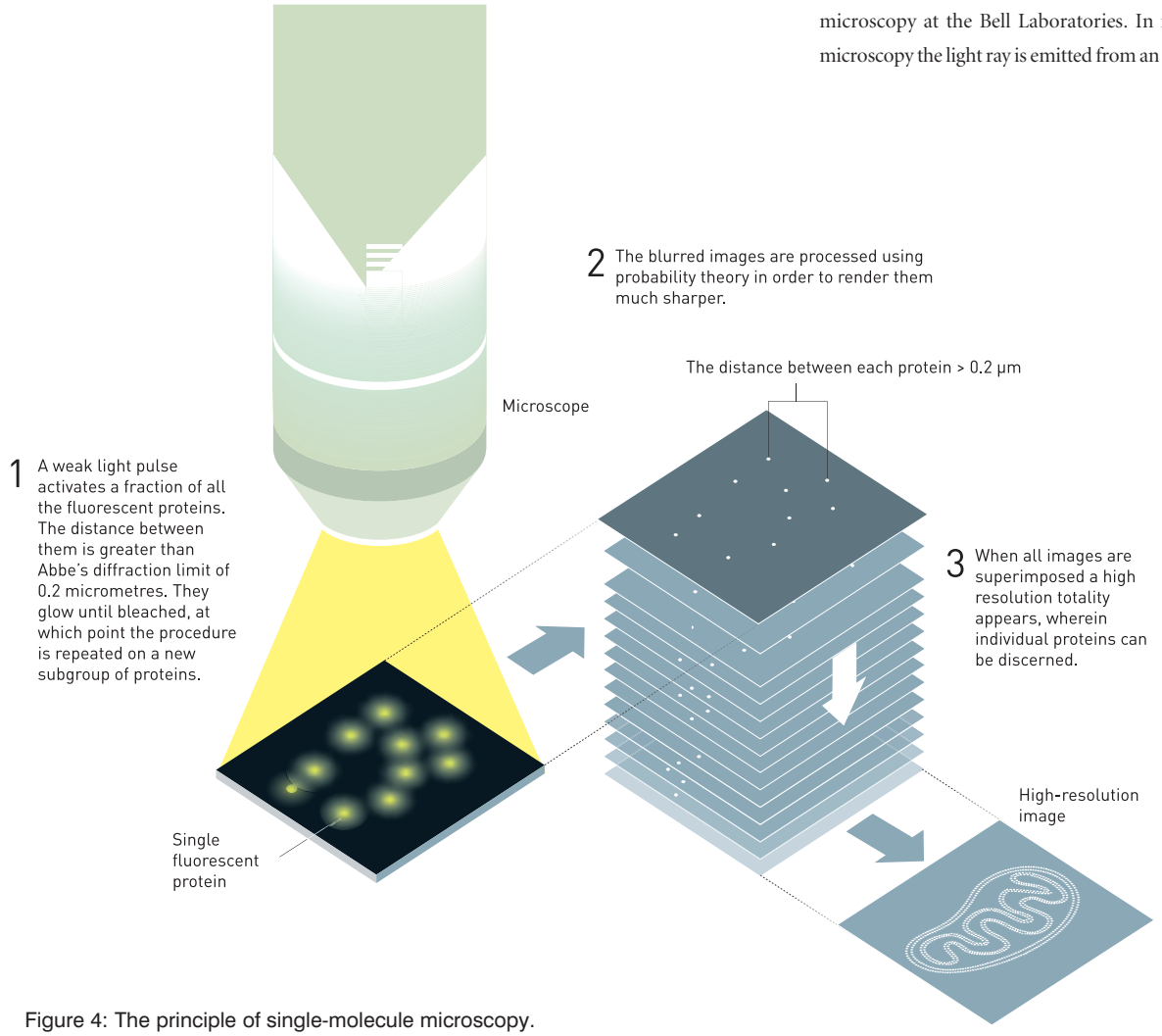


Figure 4: The principle of single-molecule microscopy.

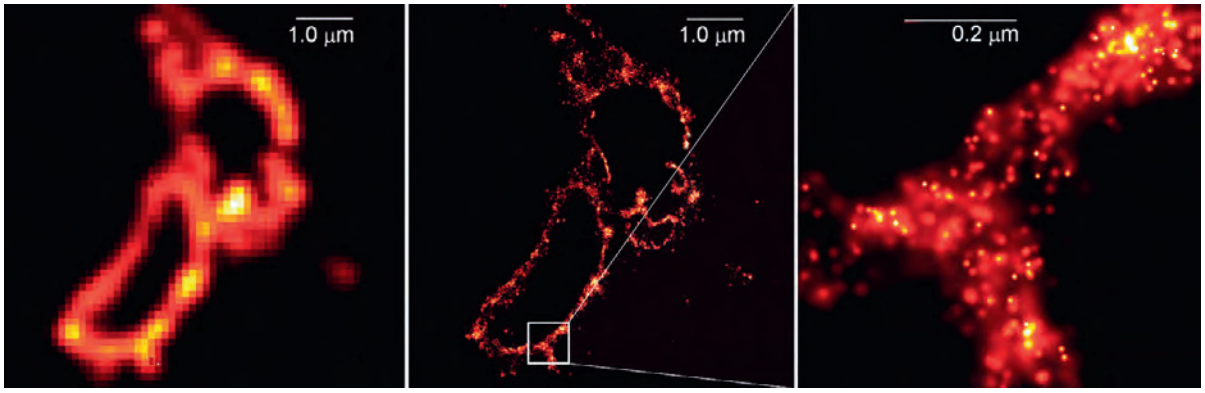


Figure 5: The centre image shows lysosome membranes and is one of the first ones taken by Betzig using single-molecule microscopy. To the left, the same image taken using conventional microscopy. To the right, the image of the membranes has been enlarged. Note the scale division of 0.2 micrometres, equivalent to Abbe's diffraction limit. The resolution is many times improved. Image from *Science* 313:1642-1645.

thin tip placed only a few nanometres from the sample. This kind of microscopy can also circumvent Abbe's diffraction limit, although the method has major weaknesses - the light emitted has such a short range that it is difficult to visualise structures below the cell surface. In 1995 Eric Betzig concluded that near-field microscopy could not be improved much further but continued to ponder whether it would be possible to circumvent the diffraction limit by using molecules with different properties, molecules that fluoresced with different colours.

Inspired by W E Moerner, among others, Eric Betzig had already detected fluorescence in single molecules using near-field microscopy. He began to ponder whether a regular microscope could yield the same high resolution if different molecules glowed with different colours, such as red, yellow and green. The idea was to have the microscope register one image per colour. If all molecules of one colour were dispersed and never closer to each other than the 0.2 µm stipulated by Abbe's diffraction limit, their position could be determined very precisely. Next, when these images were superimposed, the complete image would get a resolution far better than Abbe's diffraction limit, and red, yellow and green molecules would be distinguishable even if their distance was just a few nanometres. In this manner Abbe's diffraction limit could be circumvented. However, there were some practical problems, for instance a lack of molecules with a sufficient amount of distinguishable optical properties.

A breakthrough came in 2005, when Betzig stumbled across fluorescent proteins that could be activated at will, similar to those that Moerner had detected in 1997 at the level of a single molecule. Betzig realised that such a protein was the tool required to implement his idea - the fluorescent molecules did not have to be of different colours, they could just as well fluoresce at different times.

Just one year later, Betzig demonstrated, in collaboration with scientists working on excitable fluorescent proteins, that his idea held up in practice. Among other things, the scientists coupled the glowing protein to the membrane enveloping the lysosome. Using a light pulse the proteins were activated for fluorescence, but since the pulse was so weak only a fraction of them started to glow. Due to their small number, almost all of them were positioned at a distance from each other greater than Abbe's 0.2 µm diffraction limit. Hence the position of each glowing protein could be registered very precisely in the microscope. When their fluorescence died out, a new subgroup of proteins could be activated. Again, the pulse was so weak that only a fraction of the proteins began to glow, whereupon another image was registered. This procedure was then repeated over and over again.

When Betzig superimposed the images, he ended up with a super-resolution image of the lysosome membrane. Its resolution was far better than Abbe's diffraction limit.

The methods developed by Eric Betzig, Stefan Hell and W E Moerner have led to several nanoscopy techniques and are currently used all over the world and the development of super-resolved fluorescence microscopy has won the three researchers this year's Nobel Prize in Chemistry.

Stainless steel vial filling system

TAP Biosystems has announced a stainless steel version of the fill-it system, designed for safely dispensing biohazardous materials such as vaccine stocks. The product is suited to the demands of working with highly potent vaccine stock.

The system fits into standard isolator cabinets, thus reducing the product contamination risk as well as the operator's exposure to this biohazardous material. It automatically decaps, fills and recaps a rack of 24 vaccine vials every 2 min. This ensures vial-to-vial consistency and, because there is no need for any manual intervention, makes routine vial fill and finishing safer.

Each vaccine batch is aseptically processed using GMP-certified, single-use tubing that is destroyed after use. The product's stainless steel exterior prevents corrosion and potential routes of contamination such as rust spots. It can also be sterilised after each batch run with high-strength hydrogen peroxide vapour, further reducing product contamination risk.

Sartorius Stedim Australia Pty Ltd
www.sartorius-stedim.com

Food pathogen detection system

The Thermo Scientific SureTect Real-Time PCR System combines speed and performance in an easy-to-use, compact platform. The system is designed to quickly and accurately detect chosen target microorganisms in a broad range of food matrices and samples from food manufacturing environments.

With a single enrichment step, no secondary enrichment or regrowth is required, enabling fast, simple testing. The system uses pre-filled lysis tubes for convenience and reliable, consistent cell lysis. The small instrument footprint allows for installations where bench space is at a premium. Software is both simple and intuitive, allowing for straightforward training, quick set-up and simple tracking of results.

Thermo Fisher Scientific
www.thermofisher.com.au

Laboratory acids for trace metal analysis

Avantor Performance Materials has launched high-purity laboratory acids optimised for trace metal analysis and designed to meet the needs of users in environmental, food, quality-control and other testing applications.

Marketed under the company's JT Baker brand, the Baker Instra-Analyzed Plus acids product line features a selection of widely used acids specially formulated to enable more accurate trace metal analysis in the very low parts per billion (ppb) range (most from 0.1-1 ppb).

The acids offer users upgraded capability from Avantor's Baker Instra-Analyzed acid line products. The line of high-purity acids is produced under strict protocols; quality tested for up to 64 key trace metals, such as iron and lead, to ensure purity; and packaged in environmentally friendly recyclable HDPE bottles.

Avantor Performance Materials
www.avantormaterials.com

Synthetic sorbent for SLE

Phenomenex has introduced Novum Simplified Liquid Extraction (SLE), a novel, synthetic alternative to traditional diatomaceous earth SLE (also known as supported liquid extraction) products and a simplified approach to traditional liquid-liquid extraction (LLE).

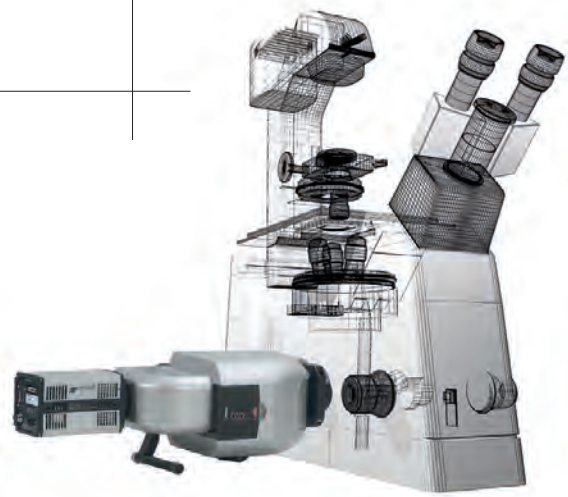
Extraction techniques used prior to LC and GC can improve results and reduce wear and tear on the instrument. The synthetic Novum SLE sorbent can be used with the same procedure as traditional SLE sorbents while delivering improved lot-to-lot reproducibility. Because it is a lab-manufactured sorbent, supplies are readily available, compared to diatomaceous earth, which is a natural resource that must be mined.

The product is said to simplify the liquid-liquid extraction process by eliminating manual steps and reducing solvent consumption. The process can also be automated using a liquid handler, improving throughput. SLE also delivers higher sample recovery than liquid-liquid extraction methods by eliminating analyte loss due to emulsions that can form at the interface of the two liquid phases.

The product is available in 96-well plates, suitable for the clean-up of biological samples such as plasma and urine. The plates feature long-drip tips that extend into the wells to reduce contamination and are available in two different loading capacities - 200 and 400 μL. SLE requires just 15 min to process a 96-well plate, compared to 25 min for other liquid extraction methods.

In the SLE process, aqueous sample is loaded onto the sorbent, which works like a sponge and retains the solvents. Target analytes can then be eluted by applying water-immiscible solvent, which is then collected in a collection plate. The solvents are not shaken, which eliminates the formation of emulsions that occur during a typical liquid-liquid extraction.

Phenomenex Australia
www.phenomenex.com



Compact, laser-free confocal microscopy system

The Andor Revolution DSD2 is a simple confocal device that delivers very good imaging performance. Its simplicity lies in a compact optical design and laser-free operation, providing ease of retrofit to an existing fluorescence microscope or an easy addition to most new models currently available.

With the addition of Andor sCMOS camera technology, the product delivers a large field of view, high dynamic range and high-resolution images around 10 times faster than laser scanning technology for good image quality. As the system uses a broadband white light source instead of lasers, it can image any fluor by selection of filters and is cost effective to maintain.

The product is suitable for fields such as developmental biology, neuroscience, embryology and plant biology. The device handles fixed samples with ease and is also capable of imaging robust live cell and embryo specimens.

SciTech Pty Ltd
www.scitech.com.au

SLE and SPE automation system

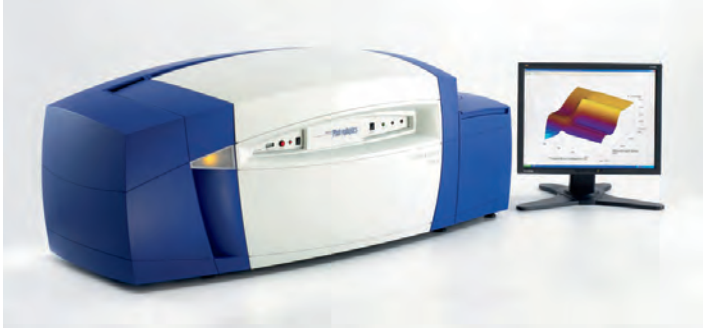
The Biotage Extrahera is an automated system for the processing of supported liquid extraction (SLE) and solid-phase extraction (SPE) methods in both plate and column formats, making the system a flexible option for a wide variety of analytical laboratories.

The compact, 8-channel automation system can handle 96 and 48 fixed well plate formats and 1, 3 or 6 mL columns. The instrument has been designed for speed and flexibility and is capable of processing a complete 96-well plate SPE method in less than 30 min. The system comes pre-loaded with Biotage SPE and SLE methods for plates and columns, while new methods can be created in minutes; using the feature-rich software, operators are able to just press Start and walk away.

By automating SPE or SLE methods, the product removes workflow bottlenecks in the laboratory; the higher throughput lowers the cost per sample of analysis and enables skilled analysts to be redeployed to other, more demanding tasks, such as data analysis. Automation ensures that samples are prepared identically every time, regardless of the sample matrix, improving accuracy and precision of results. Samples can be being generated to feed an MS system as fast as the extraction method permits and as fast as an end user can provide suitable samples for extraction.

The system has minimal moving parts with easily accessible consumables and has been designed to minimise any potential cross-contamination. Using positive pressure during processing provides control and uniformity of flows across multiple columns and wells. The enclosed working area ensures operator safety and reduces exposure to solvents and hazardous compounds.

John Morris Scientific Pty Ltd
www.johnmorris.com.au



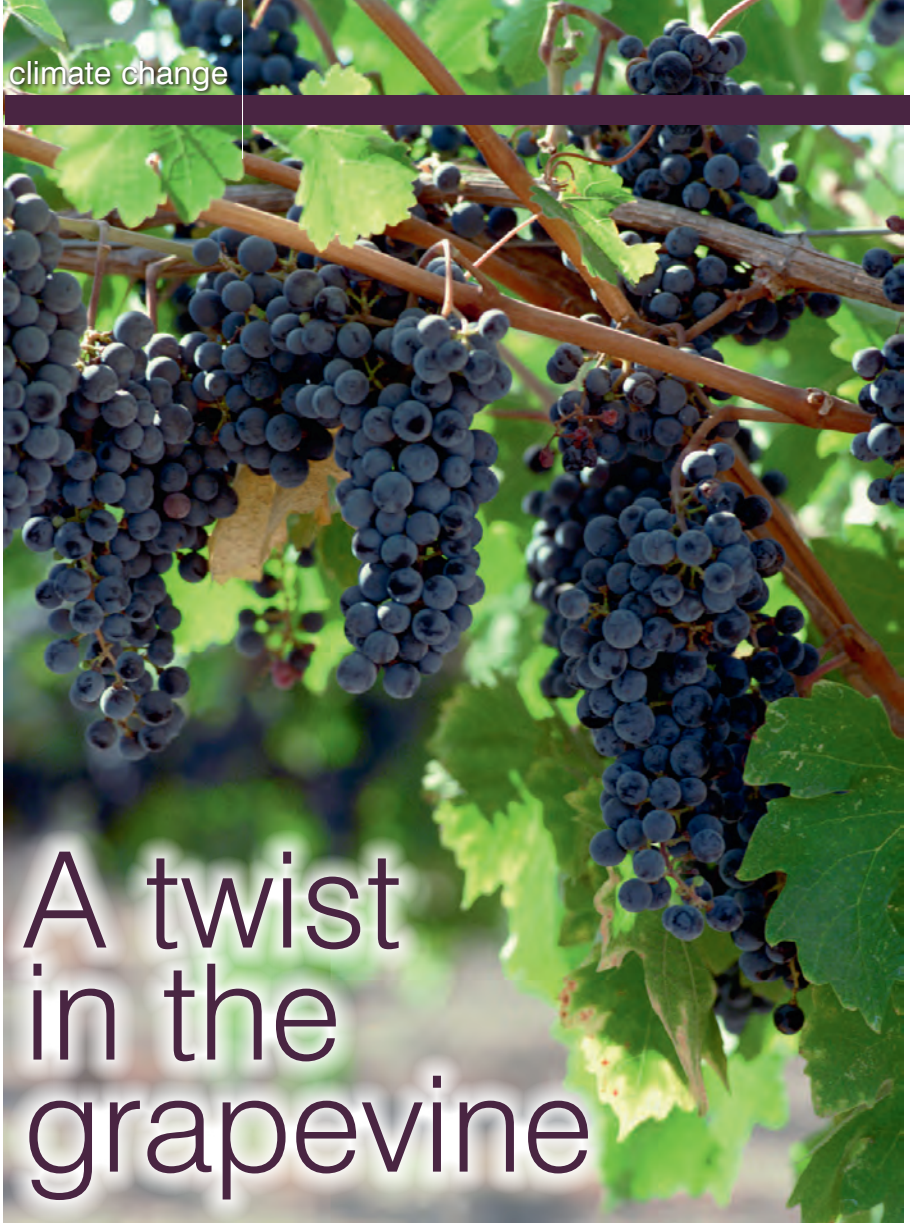
CD spectrometer

The Applied Photophysics Chirascan high-performance spectrometer, for use in circular dichroism, uses next-generation, dual-polarising prism monochromator technology. It offers good CD quality and simultaneous absorbance and optional fluorescence detected circular dichroism.

Features include: high light throughput giving good signal-to-noise ratio; CD, absorbance and FDCD; temperature profiling of proteins at multiple wavelengths in a single experiment; sealed compartments for low nitrogen usage.

Scientex Pty Ltd
www.scientex.com.au

Susan Williamson



A twist in the grapevine

Increased temperatures can alter grape berry composition and result in lower priced fruit that has reduced potential for making higher value wine. With current temperatures at optimal or above optimal levels for producing high-quality fruit and wine, grape growers are looking for new ways to control ripening to ameliorate these effects.

"South Australia produces more than half the wine made in Australia each year," said Dr Christine Böttcher, research scientist with Dr Christopher Davies' group investigating the control of grape berry at the CSIRO Agriculture Flagship in Adelaide. "Climate change is a big concern for the wine industry because of increasing temperatures and the effect this has on grapes."

Grape berry development is particularly effected by temperature - the berries develop with less colour, reduced levels of flavour and aroma compounds, and increased sugar levels.

"Increases in temperature are predicted to continue and this will affect the quality of the berries," Böttcher said.

The ripening hormone

Berry development occurs in three stages. In stage 1 the fruit set and berries begin to grow along with the development of seeds. Stage 2 involves a pause in berry growth and Stage 3 is the ripening phase where berries change colour and soften with accumulation of sugars and a reduction in organic acids.

It is this third ripening stage that is the focus of Böttcher's work.

A number of plant growth regulators are involved in ripening - abscisic acid which promotes ripening, the auxin indole-3-acetic acid (IAA) that inhibits ripening and ethylene, which has a complicated role in berry development and whose role in ripening is not yet well understood.

"Ethylene is known as the ripening hormone," said Böttcher.

Climacteric fruits such as tomatoes, apples and pears undergo a rise in cellular respiration associated with increased ethylene production upon fruit ripening. Ethylene seems to be the key in controlling ripening in climacteric fruit.

Non-climacteric fruits, such as grape and olives, produce very small amounts of ethylene - a transient increase of ethylene production occurs just before the onset of ripening (called veraison in grapes) - but this is not associated with an increase in respiration and these fruits do not respond to ethylene treatment in the way that climacteric fruits do.

How to control ripening

Böttcher has been analysing the effects of a synthetic auxin, 1-napthalene acetic acid, the ethylene-releasing substance Ethrel and another compound, aminoethoxyvinylglycine (AVG), to unravel how ripening is controlled in grapes.

"AVG inhibits ethylene biosynthesis and has the opposite effect to Ethrel when applied to pre-veraison berries," said Böttcher. "It advances ripening, whereas Ethrel treatments can lead to ripening delays.

"Ethylene levels in grapes are very low, so they are very difficult to measure," Böttcher continued. "Therefore, we have been looking at the expression of genes involved in ethylene biosynthesis and perception."

When AVG was added to cultured berries, Böttcher and colleagues found that the expression of genes encoding receptors for ethylene was decreased, a response typically seen when ethylene levels are reduced.

"The inhibition of ethylene biosynthesis by AVG provides a possible explanation for the opposite effects of Ethrel and AVG treatments on grape berry ripening," Böttcher summarised.

The twist

But there is a twist. AVG also inhibits the biosynthesis of IAA, the auxin that inhibits ripening, whereas Ethrel application increases IAA accumulation in berries. Therefore, changes in grape berry ripening elicited by Ethrel or AVG application might in fact be IAA-mediated.

Surprisingly, the researchers found that applying Ethrel a week before veraison advanced ripening, which was counter to what they expected because of the presumed increase in IAA levels by Ethrel treatment.

"We then looked at the developmental expression of genes encoding enzymes involved in the biosynthesitic pathways of IAA and ethylene and found expression patterns indicative of an ethylene-induced increase in IAA production at around the time of ripening initiation," said Böttcher.

IAA levels are low at this stage of berry development, but a conjugate of IAA with aspartic acid (IAA-Asp) rapidly accumulates, not just in grapes, but also in ripening tomatoes.

"The IAA-Asp conjugate has become a focus of our research as it might represent an ethylene-induced ripening signal in both climacteric and non-climacteric fruit," she said.

Böttcher presented the Australian Society for Plant Scientist 2014 Functional Plant Biology Best Paper Award Lecture at the 2014 ComBio meeting entitled 'Auxins or ethylene - who controls grape berry ripening?'

Total organic carbon analyser

The OI Analytical Aurora 1030 Total Organic Carbon Analyser (TOC) uses the heated persulphate wet oxidation technique to analyse organic contamination levels in aqueous samples. Virtually all organic compounds dissolved in water can be oxidised by heated sodium persulphate ($Na_2S_2O_8$).

Concentrated solutions (1 or 1.5 M) can effectively oxidise organic matter present in the form of colloids, macromolecules and suspended solids. For difficult-to-oxidise, high-molecular weight organics (eg, humic acids), the high-temperature combustion technique may be the most effective at levels >500 ppb C.

For nearly all applications, the 1030W Wet Oxidation instrument will perform well. In the event a laboratory has difficult-to-oxidise samples requiring high-temperature combustion, OI Analytical offers an instrument combining both oxidising techniques on the one machine: the Aurora 1030D Dual Oxidation Mode TOC Analyser.

The company's heated persulphate and high-temperature combustion techniques have been approved and adopted in numerous regulatory compliance methods and standards including USEPA, ASTM and ISO. To further enhance the analysis capabilities on a single platform, the company also offers an 88-position autosampler and the 1030S Solids module for solid materials.

Walker Scientific Pty Ltd
www.walkerscientific.com.au

Chemical safety services

Chemical Safety International (formerly ACOHS) is offering an expanded range of chemical safety management, audit, training, documentation, risk and advisory services.

The company supplements and support its clients' in-house technical and safety resources with regulatory monitoring, advisory services, auditing, compliance and inventory management. It ensures chemical manufacturers, suppliers, distributors and users are up to date, safe and compliant.

The company has also announced a comprehensive redevelopment of its Infosafe CSI software and services.

Chemical Safety International
www.chemicalsafety.com.au

Portable gas detector

The RKI Eagle 2 portable gas detector can be rented from TechRentals.

Suitable for the oil and gas, industrial safety, air-quality, hazmat and military sectors, the gas detector provides confined space protection for lower explosive limit (LEL), O_2, H_2S and CO. It also incorporates a photoionisation detector (PID) for volatile organic compound (VOC) monitoring.

The unit comes standard with data logging; low-flow pump shut-off and alarm; auto calibration/single gas calibration; and an IrDA communications port. It is intrinsically safe and CSA approved. Other features include methane elimination for environmental use; powerful long-life pump up to 38 m range; and an alkaline 18 h or Ni-MH 20 h capability.

TechRentals
www.techrentals.com.au

Compact data logger with built-in Bluetooth

The MSR Electronics MSR145WD data logger allows the monitoring of measured data with a built-in colour OLED graphic display, via a Bluetooth Low Energy (BLE) wireless connection or from any location using the optional web-based MSR SmartCloud service.

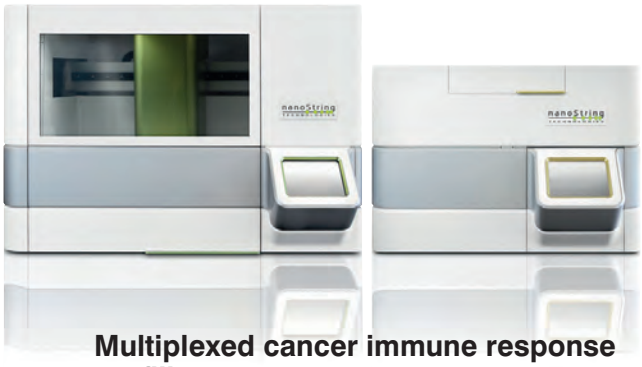
The bright, high-resolution, colour OLED display allows data and graphic charts to be viewed from virtually any viewing angle. The BLE wireless radio link is particularly advantageous for applications that require monitoring of measured data from locations that are difficult to access, such as machine rotations. BLE allows the user immediate data visualisation irrespective of the location.

The measured values can be quickly transferred to a PC, laptop or smartphone. Users can receive alarm messages via the MSR SmartCloud and, if required, share data from multiple data loggers with a team at any time.

The device can be configured with up to five internal or external sensors. Available sensors include three-axis acceleration, temperature, humidity, air pressure and light sensors.

Due to its high-capacity battery and its ability to store over one million measurements, the product is suitable for long-term data acquisition applications. It can be supplied in a standard IP60 housing or a waterproof IP67 housing.

Interworld Electronics and Computer Industries
www.ieci.com.au



Multiplexed cancer immune response profiling

The nCounter PanCancer Immune Profiling Panel is a novel gene expression panel that enables researchers to develop profiles of the human immune response in all cancer types.

In collaboration with cancer immunologists around the globe, the 770-plex gene panel combines markers for 24 different immune cell types and populations, 30 common cancer antigens and genes that represent all categories of immune response including key checkpoint blockade genes.

Twelve separate samples can be fully profiled for all 770 genes per run and high-precision digital data is available from the system the next day.

Bio-Strategy Pty Ltd
www.bio-strategy.com

Cell lysis RT-qPCR kits

Bio-Rad Laboratories has announced the launch of a rapid cell lysis kit that allows researchers to obtain reverse transcription quantitative PCR (RT-qPCR) data directly from cultured cells without the need for a separate RNA purification step. The SingleShot family of cell lysis RT-qPCR kits provide high-quality gene expression results in less than 2 h.

Available column isolation methods for purifying RNA are said to be time consuming and laborious, while other methods that enable RT-qPCR directly from cell lysates can damage the RNA and result in poor genomic DNA clearance. The kits eliminate such challenges and offer good reproducibility and accuracy of gene expression results. Minimal set-up and pipetting steps create an automation-friendly workflow and, unlike other similar methods, the kits do not require an additional pipetting step to stop the cell lysis reaction.

The kits are suited for high-throughput laboratories with large-volume workloads and for researchers who are faced with a limited number of cells and require high accuracy in each analysis. They include an RNA control template and qPCR assay to help researchers determine optimal cell number and lysate inputs for their RT-qPCR reactions.

The kits are validated for use with a wide variety of adherent and suspension cell lines and are offered in multiple formats, including one-step RT-qPCR and two-step RT-qPCR kits that are compatible with either SYBR Green or probe-based assays. They are also available as stand-alone cell lysis kits.

Bio-Rad Laboratories Pty Ltd
www.bio-rad.com

Lysis and DNA purification system

NucleoSpin isolation technology from Macherey Nagel provides a lysis and DNA purification system for nearly all types of food samples. Even low amounts of partially degraded DNA can be purified from complex matrices including honey, pollen, bread, flour, spices, cereals, meat, pharmaceutical tablets, cosmetic creams and powders, and starter cultures.

Resulting eluates from the fast and easy protocol are ready to use for all types of subsequent detection methods, especially real-time and basic PCR technology. Sensitivity is ensured as the system completely removes PCR inhibitors. The process can also be automated on vacuum-based robotic workstations.

Scientifix Pty Ltd
www.scientifix.com.au

Three new Grand Challenges announced

© iStockphoto.com/VikramRaghuwanshi

One decade after the Bill & Melinda Gates Foundation launched the Grand Challenges in Global Health grant program - a research initiative to catalyse scientific and technological innovation to achieve major breakthroughs in global health - a group of international partners has funded three new challenges aimed at creating breakthroughs in science.

Through investments in high-risk, high-reward research, the next phase of Grand Challenges seeks bold solutions and strategies to address some of the most pressing global health and development issues of our time. The three new initiatives are:

- **All children thriving** - Focuses on developing new tools and holistic approaches to help mothers and children thrive in the developing world by ensuring a healthy birth for both mother and child and setting children on a path to healthy physical growth and cognitive development.
- **Putting women and girls at the centre of development** - Focuses on a rigorous understanding of women's and girls' needs and preferences and gender inequalities and supporting new approaches to promote women's and girls' empowerment that will enhance the ability to achieve multiple health and development goals.
- **Creating new interventions for global health** - Focuses on accelerating the translation of original and innovative concepts for vaccines, drugs and diagnostics into safe, effective, affordable and widely used interventions for diseases in the developing world.

"We know how critical women and girls are to the health and economic prosperity of their families and communities, but we don't have all the answers yet," said foundation co-chair Melinda Gates. "Over the last decade, Grand Challenges has demonstrated that when we partner together and think in bold ways about possible solutions, we get that much closer to every person realising their full potential. I am excited by the incredible opportunities that lie ahead with these new challenges."

"Melinda and I have always believed that advances in science can help reduce inequity in a big way," added co-chair Bill Gates. "But you have to be willing to take some risks and see some projects fail. That's the idea behind Grand Challenges - to focus bright scientists on the problems of the poorest, take some risks and deliver results."

Ongoing research under the original Grand Challenges in Global Health initiative includes promising projects that are speeding the development of new vaccines and strategies to prevent and treat HIV/AIDS, tuberculosis and malaria; new approaches to vector control; and a new class of point-of-care diagnostics.

Applications for grants under the new challenges will be accepted from 4 November 2014. For more information, visit http://grandchallenges.org/grant-opportunities.html.

Awards for translational research

The Translation Research Institute (TRI) is offering a $25,000 national prize to recognise Australian research that has successfully translated biomedical research into clinical practice. Four TRI awards, which recognise translational research and encourage collaboration, are also to be offered to researchers who work at the institute.

Based in Brisbane, the TRI developed the national prize to support researchers working on a technology or treatment to improve human health. Researchers who have spent over 50% of their time working in Australia over the last 5 years are eligible to enter.

The winner will receive $25,000 and the opportunity to present to high-profile researchers and clinicians on their research at an awards symposium to be held at TRI on Friday, 21 November 2014.

The four TRI awards - translational research, innovation, breakthrough and collaborative team - aim to increase participation and collaboration in translational research at TRI.

Go to the TRI website for more information.

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Funding environmental science research

Environment, biodiversity and climate research will receive a boost with the Australian Government committing $102 million over four years to the National Environmental Science Program.

The National Environmental Science Program was formed by the amalgamation of the National Environmental Research Program and the Australian Climate Change Science Program, which was announced in the 2013-14 Budget.

The program will support collaborative research and aims to provide greater cohesion between environmental and climate science.

Six research hubs will be selected for funding through a competitive process.

- Threatened species recovery.
- Marine biodiversity.
- Tropical water quality.
- Clean air and urban landscapes.
- Earth systems.
- Northern Australia environmental resources.

pH and conductivity meters

Metrohm has available the 912 Conductometer, the 913 pH Meter and the 914 pH/Conductometer. The meters are robust and easy to use.

The meters are both precision instruments for the laboratory and companions for mobile use in the field. During field use, the meters are powered by batteries. Afterwards, they can be recharged, even on the road on the cigarette lighter with the use of an adapter.

The 914 pH/Conductometer offers parallel measurement of pH and conductivity, while the 913 pH Meter features parallel recording of two pH values. Both versions indicate the temperature(s) of the sample(s). The 912 Conductometer measures the conductivity, salinity and temperature of the sample.

Ergonomic design ensures the meters fit comfortably in one hand. Each key on the clearly organised user interface comes with a secure pressure point. Hence, the meters can be operated intuitively with one's left or right thumb while the other hand remains free to hold the electrode(s) in the medium in which the measurement is done.

All three versions meet the requirements of IP67. In the office, the meter is simply plugged into the USB port of the PC and the collected data is exported straight to the LIMS or Excel or can be managed in tiBase, the Metrohm titration software.

MEP Instruments Pty Limited
www.mep.net.au

Volatile organic compound monitor

Suitable for those in the oil and gas, industrial safety, air-quality, hazmat and military sectors, the ppbRAE 3000 is a volatile organic compound (VOC) monitor with data logging functionality. The monitor is available to rent from TechRentals.

RAE Systems' VOC monitor uses a photo-ionisation detector (PID) with a 10.6 eV UV-discharge lamp. The monitor also comes with integrated correction factors for 220 compounds, and humidity compensation with integral humidity and temperature sensors.

The device features a range from 1 to 10,000 ppm, a 3 s response time, and sensor and lamp auto cleaning. It is also waterproof to IP67.

TechRentals
www.techrentals.com.au

Pressure reactor

Asynt announces PressureSyn, a 125 mL working volume high-pressure reactor that combines good performance, ease of use and a high level of operational safety. Designed by chemists and engineers, the reactors provide a suitable tool for stirred, or non-stirred, high-pressure applications including hydrogenations, carbonylations, catalyst screening and polymerisations.

Precision engineered from traceable certified 316 stainless steel, the safety features include a bursting disk and pressure relief valve. Reactors feature a bracket and key-operated locking system ensuring easy assembly. The clamping arrangement also prevents the clasp from being disassembled while the reactor is still under pressure.

Each reactor's locking collar has a unique key, which ensures only that key can be used to open that specific individual reactor. Each reactor is tested to 170 bar, witnessed and certified by Zurich Insurance, and is rated for use up to a maximum pressure of 100 bar and temperature of 200°C.

A DrySyn adapter plate ensures secure placement of the product to any standard hotplate stirrer, giving enhanced heat transfer and the ability to control temperature from the stirrer's temperature probe. An optional PTFE reduction adapter/sleeve is available for small-volume chemistry.

Asynt
http://www.asynt.com

Small DC servo motors extended encoder range

maxon DCX motors have online configuration and an automated production facility. This allows the user to directly modify the features of the motor and select various gearhead and encoder options suitable for many sustainable manufacturing applications.

The selectable range of encoders has increased with the 3-channel range of optical 2RMF and SCH sensors. Once the encoder is selected, the resolution option is given. The encoders feature a wide input voltage range. The output signal is EIA standard RS422 using an 26C31 driver.

With the configuration tool, the user can select a low backlash gearhead or maxon can supply zero-backlash, high-reduction gearheads that, when used in conjunction with the 5000cpt, will give the user a 20,000 quad count position capability. Multiply this by the gearhead ratio selection and the result is an accurate positioning drive.

maxon motor Australia Pty Ltd
www.maxonmotor.com.au

Donning and doffing

- why protective gear protocols are crucial

The current Ebola crisis has demonstrated that 'inadvertent' contamination is very hard to eradicate and can have deadly consequences.

Personal protective gear offers scientists and healthcare workers very high levels of protection but just wearing it while you work is not enough. How personal protective gear is removed is just as crucial as wearing it if you want to prevent exposure to contaminants such as viruses. Rigorous steps exist - and must be taken - to avoid inadvertent contact of exposed skin and mucous membranes to infected body fluids.

According to physician-specialists from Johns Hopkins and the University of North Carolina, personal protective equipment, including goggles or face shields, gloves and gowns, is effectively decreasing West African caregivers' exposure to infected bodily fluids, but workers are still at risk "if removal of protective clothing that is contaminated with infectious bodily fluids is not done in a manner that prevents exposure". Trish M Perl, MD, MS and Noreen Hynes, MD, MPH are two Johns Hopkins infectious disease experts who authored a commentary published online in the *Annals of Internal Medicine*.

"The physical exhaustion and emotional fatigue that come with caring for patients infected with Ebola may further increase the chance of an inadvertent exposure to bodily fluids on the outside of the personal protective equipment, leading to unwanted contact when the gear is removed," the authors say. "The impulse to wipe away sweat in the ever-present hot, humid environment during personal protective equipment removal may lead to inadvertent inoculation of mucous membranes" in and on the nose, mouth and eyes.

According to the World Health Organization, the unprecedented outbreak of Ebola in West Africa has resulted in a "high proportion of doctors, nurses and other health care workers who have been infected".

The World Health Organization claims that more than 240 health care workers have developed the disease in Guinea, Liberia, Nigeria and Sierra Leone. More than 120 have died, including prominent doctors in Sierra Leone and Liberia.

Despite the challenges of preventing inadvertent exposure from improper personal protective equipment removal, they say that health care workers are generally aware of and are using proper precautions.

For example, treatment sites in Africa administered by Médecins Sans Frontières, a medical humanitarian organisation, have established a systematic process to mitigate the risks associated with removal of personal protective equipment, including a buddy system in which health care workers walk each other through each step of the removal process to help ensure safety.

Johns Hopkins Office of Critical Event Preparedness and Response (CEPAR), in collaboration with Perl, has established a number of clinical guidelines and tools to ensure Johns Hopkins hospitals, outpatient clinics and primary care offices take adequate precautions when encountering patients who have had a history of recent travel to West Africa.

Such precautions include proper procedures for the donning and doffing of PPE for any patient identified as having such a travel history and who has symptoms associated with Ebola.

"Despite its lethal nature, Ebola transmission can be interrupted with simple interventions and by focusing on basics. Improvement in basic health care infrastructure and providing an adequate supply of personal protective equipment, along with a ritualized process for donning and doffing personal protective equipment, are desperately needed to prevent further unnecessary infection and loss of life among the heroic health care workers who are on the front lines of this war," the authors write in the commentary.

Perl is senior epidemiologist for the Johns Hopkins Health System and a consultant to the CEPAR, which is overseeing and coordinating Johns Hopkins' readiness for any potential Ebola patient. Hynes is the director of the Geographic Medicine Center in the Division of Infectious Diseases.

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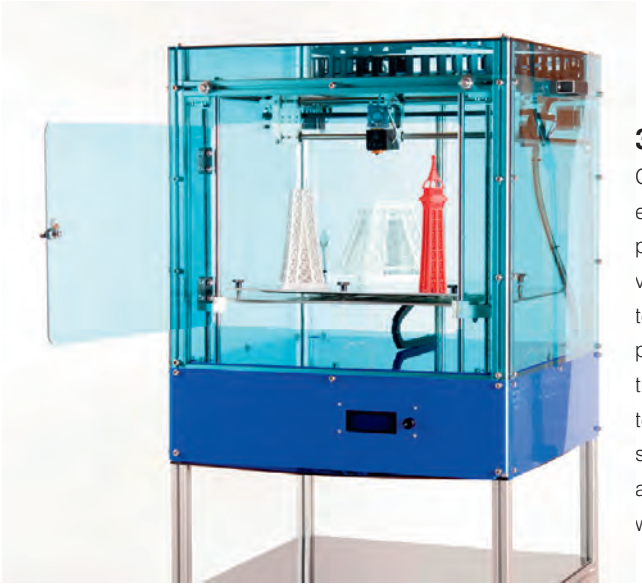


3D printer

GermanRepRap's X400 3D printer meets the requirements of professional construction and development departments for prototyping, as well as small batch production. Made in Germany, the product utilises OpenSource technology. It is suitable for design, engineering, manufacturing and electronic businesses as well as ambitious private users.

The printer has an overall dimension of 650 x 650 x 700 mm, weighs 35 kg and has a printing volume of 56 L. It is available as a kit, with an acrylic case to reduce model warping and a base cabinet for additional storage available as options. The printer can be equipped with a ceramic heated bed.

The product supports layer thicknesses between 0.1 and 1 mm and a printing volume of 400 x 400 x 350 mm allows the printing of precise and large models. Many different plastics may be used, such as PLA, ABS and PP. With the optional second extruder, the user may print in multiple plastic types, colours or support material. Three 2.2 kg filament spools can be accommodated within the printer.

The electronic components are compatible with the OpenSource RepRap Software.

GermanRepRap Australia
www.germanreprap.com.au

Multiplex biomarker analysis platform

MyCartis has announced the launch of Evalution, a multiplex biomarker analysis platform for the life sciences research market.

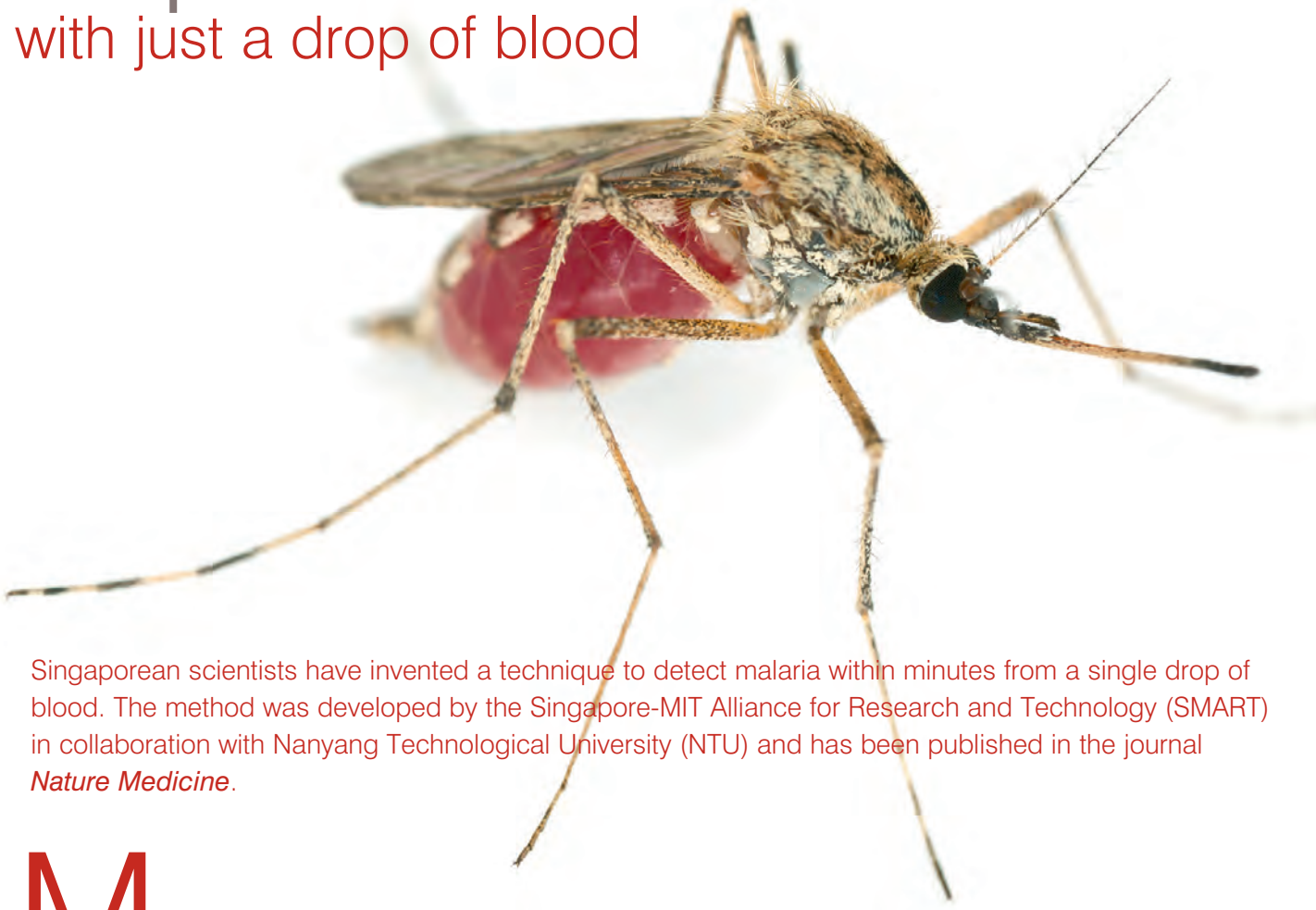
The digital multiplex analysis platform is tailored to clinical research and pharmaceutical markets and designed to analyse a broad range of protein and nucleic acid-based biomarkers, delivering high-quality data and rapid results. It provides an integrated reaction and detection environment and simultaneous analysis of large numbers of analytes per assay.

The product will support researchers to better understand the role of biomarkers in early disease and risk diagnosis, and patient management. It can analyse an individual's protein and molecular profile in a single assay plate.

MyCartis
www.mycartis.net

Rapid malaria detection

with just a drop of blood



Singaporean scientists have invented a technique to detect malaria within minutes from a single drop of blood. The method was developed by the Singapore-MIT Alliance for Research and Technology (SMART) in collaboration with Nanyang Technological University (NTU) and has been published in the journal *Nature Medicine*.

Malaria affects over 60 million people worldwide and could be fatal in serious cases, but there is no vaccine and antimalarial drugs are losing their efficacy. Furthermore, malaria infection is still detected via stained blood smear microscopy. A lab technician will need to spot the tiny parasitised red blood cells among millions of uninfected red blood cells, especially in the case of early infection, which is like finding a needle in a haystack - and often not conclusive. Other malaria diagnostic techniques, such as polymerase chain reaction (PCR), are not field-deployable and can only provide semi-quantitative analysis.

The SMART solution works by detecting hemozoin crystallites - the metabolic waste product of the haemoglobin consumed by malaria parasites at the onset of the disease. The crystallites are basically oxidised iron nanoparticles (Fe^{3+}), making them more 'magnetic' than the healthy red blood cells. The new technique uses a miniaturised magnetic resonance relaxometry (MRR) system, a cousin of magnetic resonance imaging (MRI), making it more sensitive, more accurate and faster than traditional methods.

The technique detects malaria infections at a very early stage, even when the amount of parasites in the blood is extremely low. It was successfully proven in mouse studies and the team is currently working on a human study in clinical settings.

"This system is more reliable and allows for rapid screening to be conducted," said Professor Han Jongyoon, the principal investigator from SMART's BioSystems and Micromechanics (BioSyM) Interdisciplinary Research Group (IRG). "So, given the flux of people moving in and out of developed nations especially, this system has the potential to help prevent mass import of malaria by infected persons. For developing nations, this system, which does not require refrigeration or other extensive infrastructure, is portable enough to be deployed in rural areas to help rapidly screen for malaria and hence stem the spread of this infectious disease."

Professor Peter Preiser, SMART Co-Investigator and Chair of NTU's School of Biological Sciences, said the test has the additional potential to rapidly detect parasites that are resistant to antimalarial drugs, particularly artemisinin, thereby providing a valuable tool in trying to prevent the global spread of these resistant parasites.

"Importantly, rapid and accurate diagnosis will reduce the prescription of drugs to non-infected people - one factor that contributes to why we are seeing more malaria parasites developing resistance to antimalarial drugs," said Professor Preiser.

SMART Research Scientist Dr Brian Peng Weng Kung, the lead author of the paper, added that the mini MRI system is "much cheaper to produce than the million-dollar MRI machines used by hospitals".

"We built tiny radiofrequency (RF) coil which is used to apply RF pulses and receive a signal from a drop of blood, and the whole detection process happens in a few minutes," he said. "Furthermore, since this technique does not rely on immunoassay labelling that requires expensive chemical reagents, we are able to bring down the screening test cost to less than S$0.10 per test."

SMART is now spinning off a company to commercialise the technology, which could work for other types of blood disorders. The research team is also setting up field-tests in South-East Asia, where they will test if the system can be run on solar power.

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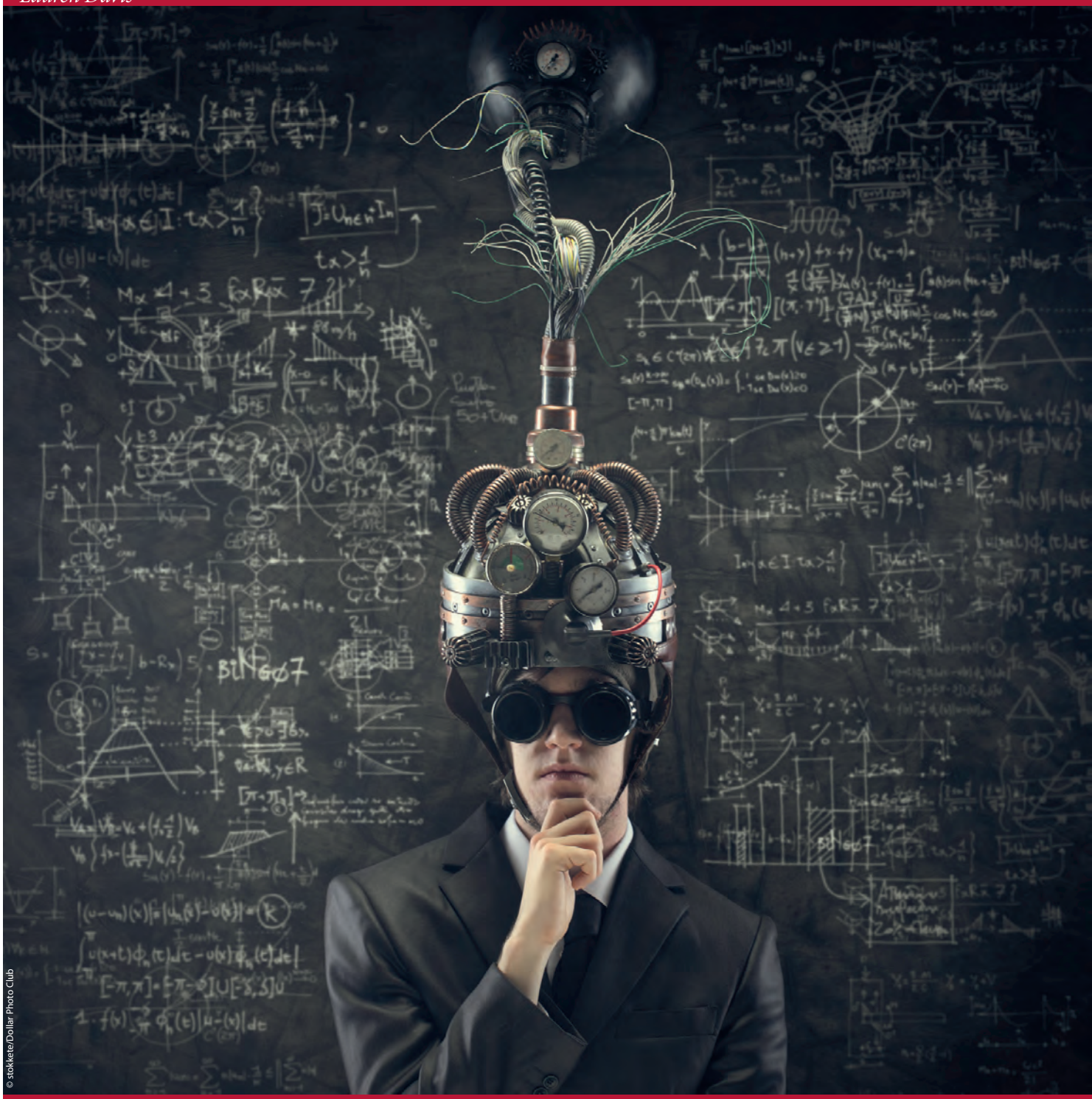
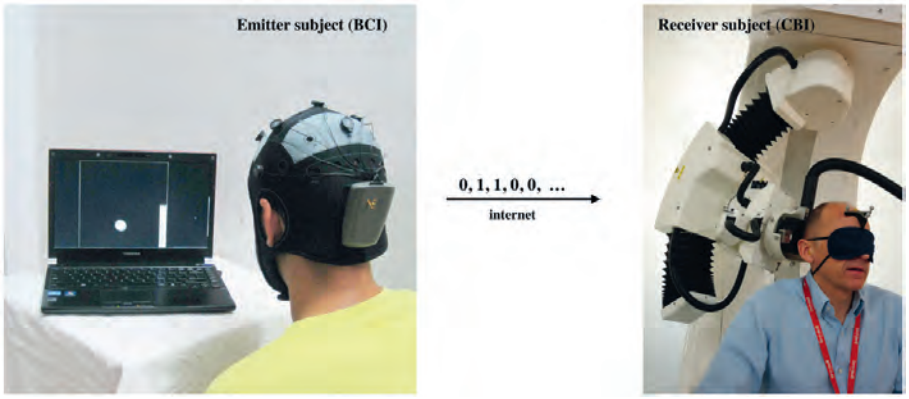


A meeting of the minds

The idea of telepathy - ie, the ability for two people to communicate using nothing but their minds - is a common notion in science fiction but not so believable in the real world. Yet while such a direct link is yet to be established, an international research collaboration has built a pathway that makes brain-to-brain communication possible - with a little help from the internet.



View of emitter and receiver subjects with non-invasive devices supporting, respectively, the BCI based on EEG changes driven by motor imagery (left) and the CBI based on the reception of phosphenes elicited by a neuronavigated TMS (right). The successfully transmitted code in the particular scenario shown is a '0': the target and ball are at the bottom of the screen and the TMS coil is in the orientation not producing phosphenes. doi:10.1371/journal.pone.0105225.g002

The team comprised researchers from Spain, France and the USA and was led by Giulio Ruffini, the CEO of Starlab Barcelona. Writing in the journal *PLOS ONE*, the scientists expressed their belief that we are entering a new era in which the minds or brains of different individuals will be able to communicate. They noted the development of brain-computer interfaces (BCIs) and computer-brain interfaces (CBIs), the latter enabled by non-invasive brain stimulation techniques.

The combination of these two technologies, according to the researchers, can be combined to realise "non-invasive, computer-mediated brain-to-brain (B2B) communication between subjects". In light of this, the team recruited four healthy study participants: one 'emitter' assigned to the BCI branch of the experiment in India and three 'receivers' to the CBI branch in France. The aim of the experiment was to successfully transmit a message from the emitter to the receivers using the internet as a pathway.

The message was encoded as a series of 0s and 1s, represented to the emitter as target cues on a screen (in the downright part of the screen for bit value 0 and the upright part for bit value 1). The emitter utilised electroencephalography (EEG) through motor imagery - if the bit in question was a 1, the emitter was to think about moving their hands (for 0, their feet). These thoughts controlled a ball on the screen that moved towards the target. If the ball hit the target, the bit was correctly encoded. The result was sent via email to the CBI subsystem.

On the other end of the experiment, the CBI subjects received pulses of transcranial magnetic stimulation (TMS) to the brain, delivered by a robotised TMS system, which would induce the perception of light flashes called phosphenes. The researchers identified a TMS phosphene-producing hotspot in the right visual occipital cortex, which was used for the active condition (to encode the bit value '1'). The intensity of pulses was adjusted for each subject, as was the occipital cortex site targeted for the silent condition (0). Various measures were employed to ensure subjects were not receiving tactile, visual or auditory cues from the positioning of the TMS coil.

The first message - "hola" - was encoded and delivered to France via email on 28 March 2014. It was delivered as TMS pulses to receiver subject 3, who reported verbally when they saw a phosphene. The same method was employed for a second message - "ciao" - on 7 April, this time to receiver subject 2. The words were encoded using a 5-bit Bacon cipher and replicated for redundancy seven times, totalling 140 bits. The resulting bit streams were randomised using cyphers selected to produce balanced pseudo-random sequences of 0s and 1s.

The researchers boasted impressive results, stating, "In the first experiment the transmission error rates were of 6%, 5% and 11% for the BCI, CBI and the combined B2B components respectively, and in the second, error rates were of 2%, 1% and 4% respectively. We note that the probability of transmission of lists of 140 items having occurred with the low observed error rates or less by chance is negligible."

But there has been some dispute surrounding the originality of the study, with the revelation of a similar experiment conducted by the University of Washington (UW) in August 2013. The pilot study, which was published on a website as opposed to in a journal, was titled 'Direct Brain-to-Brain Communication in Humans' and chronicles the use of EEG for recording brain signals from a 'sender' and TMS for stimulating the brain of a 'receiver'.

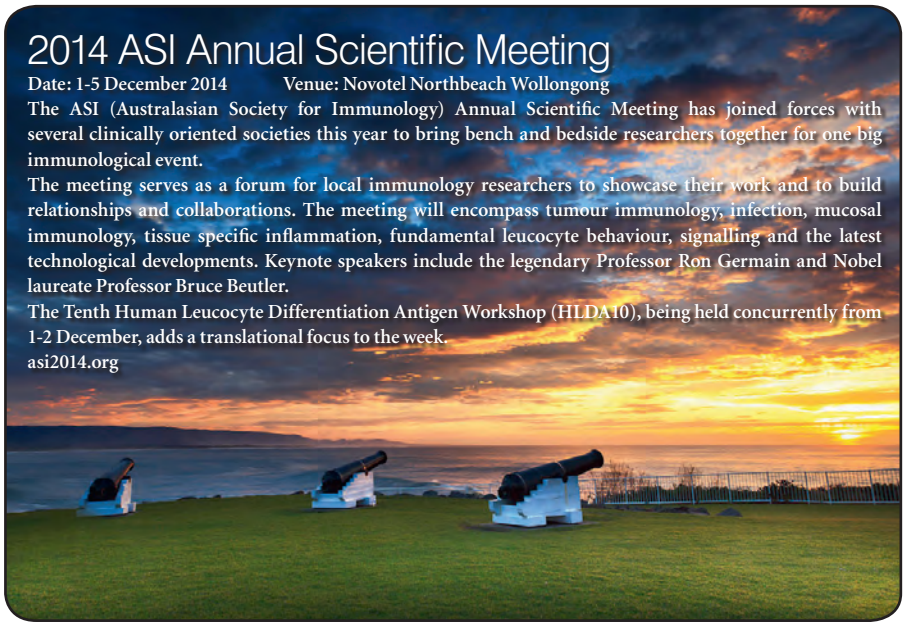
In the UW study, subjects were tasked with playing a computer game where they must fire cannons to destroy rockets heading towards a city. The sender could see what was happening on the screen but could not actually press the 'fire' key (the space bar on a keyboard). As the sender imagined moving their right hand, the signal was translated by the computer to a magnetic stimulation pulse that was delivered to the left motor cortex region of the receiver. The stimulation causes a quick upward jerk of the receiver's own right hand, which was resting slightly above the space bar and typically resulted in the key being pressed.

It is the involuntary nature of the UW receiver's movement which differentiates this study from Ruffini's the most, the action being subconscious as opposed to conscious. The authors of the most recent study noted three features which make their work stand apart from others: "a) the use of human emitter and receiver subjects, b) the use of fully non-invasive technology and c) the *conscious* nature of the communicated content" (emphasis added). The researchers acknowledge previous experiments in the B2B field but conclude that theirs provides "the first demonstration of non-invasive direct communication between human minds", stressing the conscious activity of the subjects involved.

Even without the controversy, Ruffini's study has not been without its critics. Many have noted the impracticality of the technique, with the experiment achieving B2B transmission at a rate of 2 bits per minute - meaning each word took 70 minutes to be fully received. This slow speed, combined with the somewhat cumbersome equipment involved, means the system will not be replacing text messaging or email as a handy form of communication any time soon. But it's a start.

"We believe these experiments represent an important first step in exploring the feasibility of complementing or bypassing traditional language-based or other motor/PNS-mediated means in interpersonal communication," the researchers said. They suggest that future work in the field could support dialogue between two or more brains or even within the same brain - ie, using information from one part of the brain to regulate phenomena (such as emotions and pain) in another.

"Our results provide a critical proof-of-principle demonstration for the development of conscious B2B communication technologies," the authors concluded. "More fully developed, related implementations will open new research venues in cognitive, social and clinical neuroscience and the scientific study of consciousness."



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www.ahmrcongress.org.au/

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events.synchrotron.org.au/conferenceDisplay.py?confId=3

Sydney Cancer Conference
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sydney.edu.au/cancer-research/SCC2014

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asi2014.org

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www.cosa2014.org

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www.ausbiotechinvest.com

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