

THE FUTURE Science class

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"I wonder what happens if . . . ," ponders a researcher. And the audacious imagination takes another leap. PAUL LLOYD presents some of those researchers, the stars of science who in 2005 have helped steer South Australia towards

its future.

Nico Voelcker

Nanotechnologist

To admit a passion for "dendrimer-based therapeutics in xenotransplantation" doesn't sound like much of a conversational gambit at any regular party setting. But when Dr Nico Voelcker talks like this, it conceals, or actually reveals, some of the most mind-boggling science going on in South Australia - the science of nanotechnology.

German-born Voelcker is senior lecturer in nanotechnology at Flinders University, which in 2000 was the world's first university to introduce a degree course in this science of thinking small (a nanometre is a millionth of a millimetre).

Nanotech promises a new industrial revolution - molecular-level factories, or weapons, or computers or body renewals. Voelcker's particular interest is medical. His achievements, such as co-developing an implant to restore vision in corneal blind patients, have attracted millions of dollars in research grants this year.

"Biosensors will significantly improve the way diseases are diagnosed," he predicts.

"Advanced biomaterials will lead to improved implants and supports for engineered tissues, including stem cells." The aim is "significant improvements in the quality of life. Watch this space".

Tanya Monro

Physicist

Medicine, industry and the military might not always have the same aims. But they can benefit equally from the work of scientists such as Professor Tanya Monro. This world authority in her field was lured to Adelaide this year to direct the Centre of Expertise in Photonics at the University of Adelaide, a centre largely funded by the Defence Science and Technology Organisation.

Her research work in Britain was about developing new classes of optical fibres (a sort of cable for conducting light). These are widely used in telecommunications; Monro is working on defence applications such as targeting systems for aircraft.

She also works on medical diagnostic and therapeutic applications and sensor systems for detecting chemicals, explosives and corrosion. Already this year, her team has ``developed a new and practical method of fabricating optical fibres containing more than 150 microscopic air holes'', which presents new possibilities.

When Monro was a child in Sydney, music very nearly became her career. That says something about her science. She says: ``Science gives great opportunity for being really creative while working on problems of real practical relevance.''

Fiona Young

Biotechnologist

Saving the world is a noble enough aim. It drove English woman Dr Fiona Young to do a PhD at Edinburgh on the chemistry of the human reproductive system. Now she's applying it in the Medical Biotechnology department at Flinders University. She became interested in a chemical, Amitraz, widely used as an insecticide, and acaricide, which affects the reproductive system of animals.

``But how could we know what was a safe level for humans?''' says Young. ``It is not ethical to test on people.''

Her breakthrough of 2005 was devising a test using human granulosa cells, which are normally discarded in the in-vitro fertilisation process.

On another front, with partners including SA Water, Young developed a similar test for the presence in water of xenoestrogens - hormone mimics implicated in some human dysfunctions.

``We're running out of water,''' Young says. ``There is concern about concentration of chemicals with recycling.''

This is part of an exciting web of biotechnology in this state, of which she says: ``Biotechnology isn't just the headline stuff of genetically modified foods and cloning; it is about getting a useful outcome out of the research.''

Derek Abbott

Electrical engineer

T-ray imaging, pioneered in Australia by London-born engineer Dr Derek Abbott, sounds sci-fi enough. This year, he established the world's first laser-based T-ray user facility in Adelaide. It's a long way from the geeky 16-year-old who was trying to translate the complete works of Shakespeare into modern English. He moved to Australia in 1986 and is now director of the University of Adelaide's Centre for Biomedical Engineering.

As an electronics engineer, Abbott still keeps diverse interests, such as his research into Pandorro's Paradox, a theory which suggests two losing strategies can be combined to form one successful one - in other words, that two wrongs can make a right.

Abbott's main work is with T-rays (Tetra-Hertz emissions, between microwaves and infra-red).

"T-rays will be of benefit in the early detection of diseases such as skin cancer, for high throughput scanning of biochips for detecting genetic disorders and for new drug discovery," he says.

"Sensitive, non-invasive biosensing will have a major impact on biomedicine and the health industry."

Jason Able

Wheat researcher

Out in the sun-gold paddocks, those naughty wheat plants are at it. It might not be sex as most humans know it, but to plant scientists such as Dr Jason Able it is a subject for intimate study. This year, Able says, "we have made significant progress towards understanding how wheat has sex".

He means the team Able leads at the University of Adelaide's Waite Campus is confidently within five years of "cracking the code" at the molecular level of the chromosome pairing in bread wheat.

The significance, with wheat just about to take over from rice and maize as the world's primary grain food, is enabling a revolution in wheat breeding at a genetic level, for example in tolerance of salinity, drought and high levels of ultraviolet light.

The Queensland-born scientist is in the right place for this work.

Nearly a third of Australia's wheat varieties were bred at the Waite, by what Able acknowledges as "some of the most respected plant scientists this country has to offer".

Few could be more respected than Tony Rathjen who, over the past three decades, has been responsible for such varieties as frame, krichauff and yitpi.

Alex Grant

Information technology

Professor Alex Grant got into home video games when he was a child. From Christies Beach High School, he graduated to developing a mathematical theory to allow engineers to calculate mobile communications system's speed limits.

His work in wireless communication has, since 1998, attracted more than \$2 million in nationally competitive research funding and more than \$1 million in commercial research projects. This is the industry - electronics - that now contributes as much to the SA economy as wine does.

Last year, Grant was SA's youngest professor, at 32, when appointed Research Professor of Information Theory at the University of SA. This year, he's had the satisfaction of succeeding with a new mobile broadband technology with the company of which he was a co-founder, Cohda Wireless.

“Low-cost, reliable wireless access to data networks is revolutionising the way we use information, both at work and in private life,” says Grant. “Wireless communications technologies also have the potential for rapid deployment in underdeveloped and rural areas, which have so much to gain from open access to the internet.”

Steve Cooper

Molecular geneticist

The ghosts from Gondwanaland are alive, deep beneath the arid red dust of the Australian Outback. Professor Steve Cooper goes fishing for them down boreholes. He has helped discover a class of subterranean critters called stygofauna, including blind beetles and transparent shrimps, in isolated underground “islands” of water, relics of the world millions of years ago.

“This contributes to a better understanding of the world and how it may respond to environmental challenges of the future, such as global warming,” says the England-born molecular geneticist who is now senior scientist at the SA Museum. The work is of particular importance to the mining industry; and contributes to making Adelaide what Cooper calls “a national hub for evolutionary biologists”.

A new recruit to this elite group is Alan Cooper (no relation), director of the Australian Centre for Ancient DNA, which he founded this year as “a new research initiative for the southern hemisphere”.

Cooper's time-travelling DNA detective work has sequenced the mitochondrial genome of the extinct moa in his native New Zealand, and shown that the kiwi was an import from Australia. In Adelaide in 2005, he discovered the pace of the molecular clock (where DNA changes are used to calculate time) accelerates in the recent past.

Reg Cahill

Physicist

If you want to get out of step, in the science industry, you have to be prepared to be called a few names. Like ``nutty''. Associate Professor Reg Cahill, acting head of the School of Chemistry, Physics and Earth Sciences at Flinders University, isn't out of step; he is marching elsewhere.

``The fundamentals of Einstein's spacetime ideas were not correct," says Cahill, challenging 100 years of physics.

This year, he ``revealed that space is a quantum system whose dynamics are determined by the fine structure constant", as he puts it. He has also observed gravity waves, ``but not of the type predicted by Einstein's theory". Flinders is now building a detector for these waves.

His book, *Process Physics: From Information Theory to Quantum Space and Matter*, was published this year.

``The absolute faith in Einstein's ideas is causing much damage to SA physics," he says. But Cahill, who as a youth came from Port Augusta with a desire ``to know why reality is the way it is", is optimistic that ``a major revolution is now under way in physics and is based here in Adelaide". He says it will have ``extraordinary implications for technological spinoffs".

Rob Fitzpatrick

Soil scientist

Soils ain't soils. They're a science to Dr Rob Fitzpatrick. As chief research scientist in CSIRO Land and Water, he has a ``passionate love" for soils. It's why he went into science in the first place, in his native South Africa.

In Adelaide, Fitzpatrick has established some international leadership in the study of acid sulphate soil which corrupts the coastline at St Kilda. It kills plants and animals and is none too kind to human activities.

Fitzpatrick has also set up the Centre for Australian Forensic Soil Science which, he says, is ``maintaining a critical mass of research expertise in soil forensics to help fight crime, terrorism and environmental pollution".

Over the past year, his forensic expertise with soils has helped solve a double murder case and identify the locality of stolen ferns, among other cases.

Fitzpatrick, who is also president of the Royal Society of SA, wants ``to link soil science, geophysics, mineralogy, chemistry and molecular biology information because these techniques will have a major future role in forensic searching".

At stake is ``the basic safety of Australians and all of humanity".

Achievements in SA

* Environmental economists Mike Young and Jim McColl, of CSIRO Land and Water, won a National Museum Eureka prize for devising schemes (already in operation) for managing water rights and allocations.

* Safer pregnancies can be expected from the award-winning work of Professor Gus Dekker, of Repromed Patient Services, and Dr Claire Roberts, of the University of Adelaide, developing tests for three pregnancy complications.

* The Australian Meteorological and Oceanographic Society medal and a Premier's Science and Research Fund grant went to Professor Matthias Tomczak, of Flinders University, for his ocean forecasting.

* Pharmacology researcher Associate Professor Libby Roughead, of the University of SA, was Tall Poppy of the Year in the national awards system which recognises excellence by young achievers in science.

* Among research groups set up this year, the Australian Mineral Research Institute in the University of SA, led by Professor John Ralston, will address the technical challenges facing the global mining industry.

* Gastroenterologist Professor Graeme Young heads the new Flinders Centre for Innovation in Cancer.

* Construction began on SABREnet, a super-broadband fibre optic network connecting the universities, government and DSTO.

* An \$800,000 grant, over five years, enables Michael Eastwood, of the Discipline of Pure Mathematics in the University of Adelaide, to continue his research into symmetry in the field of differential geometry.

* And big drum rolls, please.

University of Adelaide environmental biologist Mike Tyler won an IgNobel Prize, awarded by Harvard University for the outright quirky, for his work on what various kinds of frogs smell like.

Around the world

* The sensation of the year was Korean cloning superstar Woo Suk Hwang's paper on practical therapeutic cloning (treating patients with tissues grown from clones of their own cells).

* Second sensation of the year was Hwang's withdrawal of his paper, under questioning of his scientific methods. Now doubts hang over Hwang's high-profile claim to have created the first cloned dog.

* A boxer dog named Tasha in Cambridge, Massachusetts, provided the DNA for the first complete dog genome sequence.

* The genome of humanity's nearest relative, the chimpanzee, was also sequenced.

* Still on animals, avian flu escaped Asia this year, heading westwards with fears of a global pandemic.

* In a trial with equally wide ramifications, a Pennsylvania judge ruled that "intelligent design" was really religion in disguise, not a scientific theory.

* Discovery of bones and artifacts established that the small hobbitlike human ancestor, the remains of which had been found on the island of Flores, was not just a one-off freak.

* The Atmospheric Sciences Centre of the University of California, Berkeley, said carbon sinks were becoming less effective, and the Earth might soon lose its ability to absorb much more of the greenhouse gases raising temperature.

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