Australian Government

Dr Harvey Millar

Science Minister's Prize for Life Scientist of the Year

Mitochondria are the powerhouses of all animal and plant cells. These small semi-autonomous units have their own DNA and proteins. They deliver the energy that drives our muscles, our brain and almost all life on earth.

Surprisingly, while we know much about animal mitochondria, plant mitochondria are a mystery. Harvey Millar, a 34 year old biochemist at the University of Western Australia, is changing that.

He has already identified how plant mitochondria produce vitamin C and other antioxidants to protect cells from free radicals. He hopes that a better understanding of how mitochondria help plants handle stress will transform the way we breed plants to cope with drought, salt and other stresses.

For his early career leadership in plant biochemistry, Harvey Millar receives the 2005 Science Minister's Prize for Life Scientist of the Year.

A chemistry teacher who was a closet biochemist first fired Harvey's interest in biochemistry. Summer work with CSIRO in Canberra reinforced for him that "life is chemistry happening" and set him on a career in plant biochemistry.

Harvey took his first steps at the ANU with a PhD investigating plant mitochondria.

"One of the reasons I focussed on plants," he says, "was that plants have to sit and cope with their environment, they can't run away from it. They have to cope with their environment in good days and bad days, good years and bad years."

During his PhD Harvey investigated the mechanisms used by plant mitochondria to manage respiration. He discovered several new metabolic pathways. His work caused the re-evaluation of much previous research and has been cited over 130 times – a significant achievement for a PhD student.

The discovery took Harvey to the University of Oxford and then, since 1999, the University of Western Australia where he was awarded an Australian Research Council (ARC) QEII Fellowship at just 30 years of age.

The success of the human genome project has led to the opening up of the genomes of many plants and animals. Genes carry the codes to make proteins – the building blocks of life. The next challenge is to identify these proteins and determine what they do. It is a big challenge that has given rise to a new field of science – proteomics.

An average plant cell has some 30,000 proteins and we still don't know what most of them are, let alone what they do. The mitochondria within plant cells have 1,500 proteins. Finding out what they do is a big challenge, but possible.

To date, five hundred plant mitochondrial proteins have been identified around the world, four hundred of them by Harvey's research team. Now the team is working to understand what all these proteins do – starting with antioxidants.

Plants make and use oxygen, creating oxidants and free radicals that can do a lot of damage. Harvey has discovered how mitochondria make vitamin C and other anti-oxidants to protect the plant from the stresses of making and using oxygen.

His next challenge is to explore the wider workings of plant cells, in particular how key cellular components – mitochondria, chloroplasts and peroxisomes – work together.

"Harvey is one of the most gifted plant biochemists of his generation, his intellectual grasp of the field is excellent and his laboratory work is outstanding."

C.J. Leaver, Head, Department of Plant Sciences, University of Oxford

To advance his studies, he has developed a new facility for protein and proteomic analysis in Perth with some $4 million of support from the ARC. The facility will use one of the most powerful supercomputers in Australia.

He believes his research will bring long-term benefits for Australian agriculture.

"We are very, very good in Australia at doing applied research associated with agricultural problems. What we have lacked often is the basic research components sitting behind those applied researchers to provide them with new opportunities to tackle real problems."

"I hope that in the long-term applied researchers will be able to pick up our discoveries and use them to make plants more tolerant to drought and other stresses, to control their flowering time, and to produce higher quality products."

Autobiographical details

1971	Born Canberra
1990-1992	BSc and University Medal, ANU
1993	BSc.Hons 1st class, Division of Biochemistry and Molecular Biology, ANU
1994-1997	PhD, Division of Biochemistry and Molecular Biology, ANU, "Regulation of alternative oxidase in plant mitochondria"
1997-1999	Human Frontier Science Programme Organisation Long-Term Post-Doctoral Fellow, Department of Plant Sciences, University of Oxford
1999-2000	University Postdoctoral Research Fellow, Department of Biochemistry and Plant Science Group, University of Western Australia
2000-2001	ARC Australian Post-doctoral Research Fellow, Department of Biochemistry and Plant Science Group, University of Western Australia
2002-present	Australian Research Council QEII Fellow, School of Biomedical, Biomolecular and Chemical Sciences, University of Western Australia (promoted to Principal Research Fellow in 2004 and to Professorial Fellow in 2005)

Career highlights

2005	Chief Investigator in newly awarded ARC Centre of Excellence in Plant Energy Biology
2003	Premier's Prize for Early Career Achievement in Science (WA)
2003	Peter Goldacre Medal, the Australian Society of Plant Scientists, for research excellence in plant science by a researcher under 35
2001	Selected for the Australian Academy of Sciences' Outstanding Young Australian Researchers Video Programme
2000	Young Researcher Award, Technology Diffusion Programme, Commonwealth Department of Industry, Science and Resources
1990-1993	Undergraduate prizes at Australian National University including the 1st year Botany Prize, Australian Society for Microbiology Prize, ANU Distinguished Student Scholarship and University Medal

Research highlights

Plant respiration – determining the control of alternative oxidase and the relationships between respiration and chemical synthesis.

Mitochondrial proteomic analysis – identifying and creating a databank of the mitochondrial proteins of rice and the model plant Arabidopsis. This provided new information that could identify problem areas in crops such as sterility, and allowed comparison with mitochondria databanks from fungi and animals to better understand the workings of the mitochondria.

Identifying regulatory and signalling proteins in mitochondria.

Identifying what happens with oxidative stress and anti-oxidant defence in the mitochondria: how vitamin C and other anti-oxidants are produced, and how mitochondria and chloroplasts are effectively "hardwired" together in their response to environmental stress.

One book and 72 papers published, with over 1,400 citations.

Funding: Harvey has attracted almost $3 million from the Australian Research Council, the University of Western Australia, and the Human Frontier Science Program for research into plant mitochondria. He has also received $4 million from the Australian Research Council for infrastructure and equipment to study plant biotechnology, proteomics and genomics.