

Kathy Belov Transcript

Pathway

Hi Guys, it's really hard to follow Maria actually. My talk's nowhere near as entertaining, and I didn't think to bring any bribes, sorry! But what I will do today is tell you about how I got into my career in wildlife genetics. Now before I start can, I see a show of hands – how many of you know what you're going to do when you finish school? And how many of you think you're going to go into the sciences? That's great! And how many of you have no idea what you're going to do? Well, I was one of you guys. I had absolutely no idea what I wanted to do. When I was at high school, I realised that I was better at the sciences than I was at the humanities. So I knew I wanted to do something science based, but I had no idea what I wanted to do. And I actually went in and changed my university admission form many, many times in that process, after I had submitted it. And I was thinking, well maybe Optometry, maybe Physiotherapy but I got some really good advice. I was given the advice, that if you're not sure what you want to do, do a basic science degree, because if you have a basic science degree then you have the prerequisites and advance standing to go into a specific field if you want. And I'm really pleased that I did that. So I went through my photo albums last night and I realised that the latest photo that I could show you, was me in Year 3. The hairstyles and the big fringe and the perm really look terrible now. I didn't finish school in Year 3 but these are the subjects that I did by the time I got to Year 12. So I was doing maths, and I was doing biology and chemistry. So I was already leaning towards a science based degree but, as I said, I went and did a basic bachelor of science. I went and did that at Macquarie University.

At Uni

And I have to tell you a little secret here. The main reason that I chose Macquarie was because I didn't want to do maths in first year. And at that stage, that was the only uni where you could do a science degree and not do maths in first year. But, I majored in Molecular Genetics or Genetics and Molecular Biology. And what I really liked about the course that I did was there was flexibility. So because I was unsure of what I wanted to do, I did a bit of education subjects; I did some Russian through uni; I did some environmental studies; but on the whole, leaning towards genetics. I got to the end of my undergrad degree and I still had no idea what I wanted to do. And at the time a friend of mine was going to do an Honours degree. An Honours is a one year research project at the end of your degree. So, I did that just because I wasn't sure - what next. So during my honours year, I did two research projects. One was in the field of human genetics looking at pre-eclampsia, which is a disorder of pregnancy in women. And then I did a virology project. So you can see my interests were already in that sort of biomedical area but I still wasn't sure what I wanted to do.

After Uni

So I finished my degree and I thought, 'Well, what next?' And I think I was just really lucky, in that I bumped into one of my Honours supervisors at the shopping centre, at Macquarie Centre. And he asked me what I was doing and I said, 'Don't know'. And he said 'Would you like to come and work with me?' and I thought 'Well, why not?'

It was a research position and it was doing geno-typing of kangaroos. He'd just got a consultancy project with the Defence Force that were looking to develop some land that had been previous defence force property. And they were doing a survey of the wildlife on that property. So I took that on as a job, and I did that for about 18 months. And during that time, it was fine but I got bored quite quickly. It was the same techniques day in and day out. So once mastered them, I was starting to get a little bit restless. And I said to Des, 'Well, if this is all science is, maybe I should go and do something else. I'm not sure that this is right for me'. And it just was a happy coincidence that at the time, he said to me 'Well, there's this fellow up at Newcastle Uni, who thinks that marsupials have a really primitive immune system.' And Des said 'I don't think that's right, why don't you try and prove him wrong.' So during my spare time I started looking at the immune response in marsupials.

And I think I was really lucky because it was an area of research that there weren't too many people working in. So, every discovery I made was a big discovery, and was a publication, and there was a lot of excitement about what we started to find. During this time, I went travelling – I'd earned enough money to go travelling – and we went travelling with friends through Europe. And it was while I was travelling that I actually stopped and I thought, "You know, I really missed the lab work. I actually really like the research, so when I came back from my four months of travelling, I enrolled in a PhD. And initially I was studying part time and working full time, but then I changed over to full-time study. And I got a government scholarship while I studied.

During my PhD, I worked on Immunoglobulin genetics of marsupials and monotremes. So these are antibody molecules and I looked at the Brush Tail Possum, the Platypus, and the Echidna. And, I suppose what I'm trying to tell you is, it took me a long time to realise what I wanted to do. But once I got hooked in the research and the science I really enjoyed it.

A real job

And just last year, I finally got my real job. So this is a permanent tenure position with the university. So that means that I'm employed as a lecturer at the university where I teach genetics to vet science students, and animal and veterinary science students. But as well as that I still continue with my research and I've got a really good group of research students in the lab now, who are doing most of the bench work. And this is them here, you can see it's a real girl power team. There are a few more girls as part of the group now. This was taken about a year ago. I often get asked why it's just girls. I think girls are really passionate about wildlife conservation and there's a big interest from girls in doing this sort of research. But we certainly do welcome boys, if they were to come along.

Platypus venom

So, one of the projects that we're working on is Platypus venom. Some of you may be aware that male platypuses are venomous. They have a spur on their hind legs, which is connected to a venom gland. And they use this spur to spur other males during the breeding season. Now this venom, is really potent, it'll kill a dog if a dog gets spurred. And in humans, it causes absolute excruciating pain and the pain is so powerful, that it can't be relieved by morphine. So people need full anaesthetic blocks to control the pain. And the pain lasts for months. So we're really interested in characterising the molecules in this venom. And last year we were part of a huge international project that looked at sequencing the genome of the platypus. And our role in that genome project was characterising all of the immune genes, because of my interest in the immune system, and also the venom genes.

And we found a really neat link between immunity and venom, where some of the venom molecules have actually evolved from immune molecules. But we've also characterised a stack of completely new molecules in platypus venom and we're looking to develop this further. Some of you may know, that snake venoms have actually been used to develop for instance ace inhibitors to control heart disease. I was also reading on the internet that Gwyneth Paltrow uses a face cream that contains snake venom in it because it reduces wrinkles. So perhaps we'll have a platypus face cream coming out sometime soon.

Marsupial survival

We're also very interested in how marsupials survive, and monotremes survive, when they're first born. Here we have some pictures of some newborns. Here we have a Tamil Wallaby – a new born Tamil Wallaby. And you can see they're tiny. They're the size of a jelly bean. Here we've got an Opossum, an American Opossum. And those of you who are sitting towards the front may be able to see that here we've got babies attached to teats on the mother's belly. So, she doesn't actually have a pouch. The babies just hang on and drink milk. And here we have a platypus, of course platypuses lay eggs, but when the eggs hatch, the mothers will feed the young milk off patches on her belly. Now, when all of these animals are born they don't have any sort of immune system at all. They don't have any immunological tissue and they can't mount their own response. So how do they survive? They're obviously living in really grotty conditions. Pouches are always quite dirty. And in the platypus burrow, there's dirt and all sorts of bacteria. So we're interested in characterising the mechanisms that marsupials and monotremes use to protect their young. And we've discovered a huge range of Antimicrobial Peptides. So these are normal Peptides that punch holes in the walls of bacteria and kill the bacteria. And they're amazing peptides. Our collaborators have actually tested them on a range of bacteria and they even kill multi-drug resistant, Golden Staph. So there's great potential there to develop novel therapeutics. So perhaps one day, you'll be taking medicines that have come from marsupials and monotremes.

Devils and tumours

This is a Tasmanian Devil with Devil Facial Tumour Disease. So this is a horrible new disease that's killing our Tasmanian Devils. It's a cancer. And it's now killed two thirds of our devils. And we think that the entire species is going to be extinct in the wild, within 25 years. So to me that is truly horrifying – that we can let this happen on our watch. So we work on this disease. So what is it? Well, it's actually a contagious cancer. So it's not a bacteria or a virus. It's a cancer cell that is spread from animal to animal, when they bite each other. So my interest in this, when I started working on it, was... well, if you're transplanting cells from one animal to the other, why doesn't that animal's immune system recognise that the cells are foreign and mount an immune response against them? And really, what we're thinking of here is essentially like a skin graft or an organ transplant. Now most of you probably know that when you do get an organ transplant, you usually look to close relatives for a match, because the closer the donor and the recipient are genetically, the more likely the graft will take and it won't be rejected by the recipient's immune system. So what we did, was we proved was this disease was spreading in Tasmanian's devils because devils have such low levels of genetic diversity that the tumour is actually identical to the infected animals own cells. So they don't see them as foreign and they don't try to get rid of them. So once the tumour is implanted in

the animals it just grows until it kills the animal... usually from starvation because the tumour appears around their face and around their teeth, and they can't feed themselves anymore.

Genetics in devils

So, just a little bit of genetics. At the top here, we have a cell that shows the level of diversity in Devils in Eastern Tasmania. And you can see that these Devils are quite similar to each other. Each lane is a different Devil. So the Eastern population of Tasmania has the disease and these Devils are all very similar. When we started looking at the Devils at the North West, we got really excited because you could see from here that there is a lot of genetic diversity in these North-western Devils. So this was one of those eureka moments, where we got actually very excited, because we started thinking, 'Well, maybe if these Devils are different, they have a hope of recognising the tumour cell is foreign, and mounting an immune response against it.' And here we have a picture of Tasmania. The grey bits represent the areas the Devils live in. This red line represents the disease front. So Devil Facial Tumour Disease was first seen in Mount William in 1996. And it's been spreading westward since then, and this red line shows where the disease is now. And these pie charts show the populations that we've studied and the number of different genetic types that we see. So you can see that this population there are only two types, up here there are three. But on the whole in the east there is very little genetic diversity. What's really exciting and interesting is when we get to this population here, West Pencil Pine, we see more genetic diversity. And we've actually seen the rate of spread of the disease slow down, which is promising. So the question we're trying to ask is "Are these genetically different Devils resistant to the disease? Will some animals survive?"

Disease resistant

Some of you may have heard about Cedric. Cedric is a bit of a media star. He's been on *60 Minutes* and he's been on all sorts of shows. He is one of these genetically different animals that we're interested in. And he was part of an important experimental trial. He and his brother Clinky were actually injected with killed tumour cells. Cedric mounted an antibody response against the killed tumour cells. Clinky, who was similar to the tumour, didn't. So they were boosted a few times and then injected with live cells. Now Clinky, unfortunately, as you can expect, did develop the disease, whereas Cedric didn't. And we all had great hopes for Cedric. Unfortunately about nine months later he was injected with a different strain of the disease and five months later he developed the disease. So while it's possible he was resistant to one strain, he's not resistant to another. So... people often ask me, "Do you think there are resistant Devils out there?"

I think it's possible that there are Devils resistant to particular strains. But I think it's quite unlikely that we have devils that are resistant to all the strains that seem to be emerging. And there seems to be a very strong selection for evolution of the disease.

Insurance populations

So I think our best hope is to start setting up insurance populations. And this project is well under way now, where we're setting up captive breeding programs of Tassie Devils. There's a good program going on at Taronga Zoo, if you're up there. The other place I can really recommend is the Australian Reptile Park. You really do get to see the Devils up there and see them up close. So, Devils

are being brought into captivity. We're trying to get a good genetic representation now, before it's too late and maintain these animals in captivity, 'til it's possible to start releasing them back into the wild. You can see here, some of the photos of the new Devils being born. The mother actually has four teats, so each mother can hold about, well, can hold four young. But she will actually give birth to about 20 young, so that in itself, can be quite interesting.

Research is fun

This is the fun part of my job. I get to go and play with the baby animals, and I must say, that makes the job very worth while. One of the things that I wasn't told about before I started my career in research, is that, it's not a case that you're stuck in a lab every day, day in day out. Research is actually a very interactive teamwork type career. I travel a lot. There are lots of international meetings. With the genome projects that I've been working on, they're really big international teams. This was a team that was involved in the Opossum genome project, the American marsupial. And the photo was taken in Cold Spring Harbour, near New York. This was another team I worked on and the photo was taken in Santa Fe, in the US. So we do a lot of travelling, I go overseas a couple of times a year. I travel a lot throughout Australia and you do get to work with a lot of fun people. This photo here was taken in Tasmania with the Tasmanian devil researchers. So you can see that there is a fun social side to research as well. I think the days of scientist working on their own are long gone and now it's very much interactive. One of the things I really didn't expect when I went into this field was doing media. And I never would have imagined that I'd be standing here talking to you guys. I was terrified of public speaking when I launched into this. But I've done a lot of media over the past few years: so, documentaries for TV shows; appearances in things like *Catalyst* and *Totally Wild*; a lot of radio – last week I talked to German radio, the week before French radio; and a lot of media – you know, a lot of newspapers and magazines articles. I even got to do one of those glossy photo shoots with the full hair and make up. And that's something you never imagine that a scientist would get to do; certainly nothing I've ever imagined, so it's a fun ride. But I think in the end, for me, it's all about the animals. And I suppose the biggest advice I can give you guys is to follow your interest, and do something you're really passionate about. Because if you enjoy what you do, it's a lot of fun to get up in the morning and go to a job where you're doing something you really do enjoy. And your science does really become a bit of a hobby, rather than a job. So I'll leave it there but I'm happy to take questions if you have any questions about the sort of research that I do. Thanks for your attention. (Audience applauds)

Resources

These resources may be accessed via the Teaching and Learning Exchange www.tale.edu.au

Science Talk 2008 (features four young Tall Poppies, including Nikki Verrills who investigates how a gene changes breast cancer cells.):

[http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/scitalk08/index.htm?Signature=\(eb1494ae-b71b-4de1-ad18-ff804ba559e7\)](http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/scitalk08/index.htm?Signature=(eb1494ae-b71b-4de1-ad18-ff804ba559e7))

Cells alive (microscopic pictures, including microbes, immune cells, bacteria, parasites, and aquatic organisms):

<http://www.cellsalive.com/>

DNA interactive:

<http://www.dnai.org/>

Understanding genetics (includes interactive animations):

<http://www.gsk.com/research/about/about.htm>

Science

Syllabus links

This resource is based on outcomes from the NSW Board of Studies 7-10 Science syllabus and the Preliminary and HSC Biology Syllabuses.

- BOS Science 7 to 10 syllabus link.

Stage 4/5 - Prescribed Focus Areas

Students will develop knowledge and understanding of:

- the history of science
- the nature and practice of science
- applications and uses of science
- current issues, research and development.

(5.8.1) Cell theory

- explain that systems in multicellular organisms serve the needs of cells
- identify the role of cell division in growth, repair and reproduction in multicellular organisms.

Cell theory (optional)

- describe cell processes that transfer genetic information from generation to generation during cell reproduction
- identify the role of mitosis and cell differentiation during the production of new cells for growth and replacement of damaged cells

Biology

Stage 6 – Prescribed Focus Areas

History of biology:

Knowledge of the historical background of biology is important for an adequate understanding of the origins, functioning and evolution of living organisms. Students should develop knowledge of:

- the progressive accumulation of knowledge about living things and their environment
- the part that an understanding of living things and their environment plays in shaping society
- how our understanding of living things and their environment is influenced by society.

Nature and practice of biology:

A study of biology should enable students to participate in scientific activities and develop knowledge of the practice of biology. Students should develop knowledge of the provisional nature of biological explanations and the complex relationship between:

- existing biological views and the evidence supporting these
- the process and methods of exploring, generating, testing and relating ideas
- the stimulation provided by technological advances in understanding biology
- the constraints imposed on understanding biology by the limitations of current technology and the stimulation this provides for the development of the required technology and technological advances.

Applications and uses of biology:

Setting the study of biology into broader contexts allows students to deal with real problems and applications. The study of biology should increase students' knowledge of:

- the relevance, usefulness and applicability of biological concepts and principles
- how increases in our understanding in biology have led to the development of useful technologies and systems
- the contributions biology has made to society, with particular emphasis on Australian achievements.

Current issues, research and developments in biology

- areas currently being researched in biology
- career opportunities in biology and related fields
- events reported in the media that require an understanding of some aspect of biology.

(8.3) Patterns in nature: (8.3.5) Maintenance of organisms requires growth and repair.

(9.4) The search for better health: (9.4.6) Epidemiological studies involve the collection and careful statistical analysis of large quantities of data. Such studies assist the causal identification of non-infectious diseases.

(9.7) Genetics: The code broken - option:

(9.7.5) Gene therapy is possible once the genes responsible for harmful conditions are identified

(9.7.6) Mechanisms of genetic change.

Extract from Science 7 to 10 syllabus, and Preliminary and HSC science syllabuses July 2009, © Board of Studies², NSW.

Quality teaching

This resource provides opportunities to incorporate the following elements of Quality teaching in NSW public schools by:

- * giving students an opportunity to discover the nature and practice of science (Deep knowledge, Connectedness, Metalanguage, Knowledge integration)
- * highlighting the dynamic nature of research in genetics and connections to nature (Problematic knowledge, Higher-order thinking)
- * stimulating thought about what inspires people to become scientists (Connectedness, Problematic knowledge).

Websites

Visit these websites for more information on the work of Dr Kathy Belov.

University of Sydney – Faculty of Veterinary Science

<http://www.vetsci.usyd.edu.au/Foundation/help/devil.shtml>

Comparative genomics:

<http://www.genome.gov/11509542>

Save the Tasmanian Devil:

<http://tassiedevil.com.au/>

Australian animals: Tasmanian Devil

<http://australian-animals.net/devil.htm>