Science Show

on ABC Radio National

Forum - Science as a career

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Robyn Williams chairs a forum at the Australian Academy of Science in Canberra where a panel of scientists discuss science as a career. What moved them to choose science, and what does the future hold for those entering scientific fields today.

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Transcript

Robyn Williams: Let's now join a panel at the Australian Academy of Sciences in Canberra during National Science Week. They are Dr. Penny Sackett of Mount Stromlo Observatory risen from the ashes after the fire in 2003, Professor Jenny Graves of the Australian National University, engineer James Bradfield Moody and last year's Nobelist Professor Barry Marshall. How did they all get into this wild and wonderful trade?

Penny Sackett: Hello, my name is Penny Sackett and I'm now an astronomer. Before that I probably would have called myself someone who was interested in science generally and before that I was just a child who was interested in everything and it's my view actually that all children are natural scientists because they're curious and they want to know why. And they will not stop asking the question until they understand why and that's really I believe what a scientist is. Someone who is willing to use whatever tools are available whether they be observation, mathematics, literature studies, whatever is required to understand why.

I would say that I started thinking about why then at a very young age. I had the advantage of parents who were not afraid of numbers, my mother was an accountant and my father repaired business machines, things that we now call computers. And so because of that they viewed mathematics as simply one of the languages that you can use to describe things, which I think was an advantage to me in my youth. When I was in high school I had a teacher in physics who really changed my life and it was at that point that I decided to spend less time on biology which had been my previous love despite the fact that my father told me that physics was about the study of levers and pulleys. Which should have frightened me off. And then I went into college to study more physics still, not even knowing at that moment what a physicist did; having no idea, only knowing that I loved physics.

And physics is a wonderful study on which you can base further effort in science in many disciplines and the one that I've eventually found my way through in a very circuitous path is astronomy and I'm very happy to be here indeed. And at this moment I have the pleasure of being the director of one of the greatest research schools in the world in astronomy and astrophysics and that's the Research School at ANU on Mount Stromlo.

Robyn Williams: And a quick question before we move on to Jenny of the genome, Mount Stromlo - is it being rebuilt?

Penny Sackett: Absolutely. I invite people to come and have a look and see it, that rebuilt process in place. Of course the core of what made that school great never left and that was the talent and the teamwork and the people itself.

Robyn Williams: Jenny.

Jenny Graves: Well I head a group that I call comparative genomics which is a wonderful name because it means I can do whatever I like. So what I compare is largely Australian animals and I got stuck into Australian animals when I came back from Berkley where I got my PhD. Quite by accident a friend of mine said, oh how about working on kangaroos and I said, kangaroos, I'm not going to be one of these scientists that end up working on the local fauna. However, I very quickly found that the local fauna were an absolute gold mine of new information and I've been working on kangaroos and platypuses, snakes and birds and all kinds of things, always comparing them. In fact generally we compare them with humans. So I've had an absolutely wonderful career comparing things, particularly the kangaroo genome and the tamil wallaby genome which we're getting completely sequenced now and a huge amount of data is coming out of this.

And what I find exciting is not the genome itself, I find it's just a whole bunch of As, and Ts and Gs and Cs, but comparing them you get an idea of how it got to be that way. And generally the reasons are not because it works better that way but because some decision was made 100 years ago to change something or other and we're stuck with that now. So it's all about compromise and it's all about change and I find evolution absolutely fascinating, it's sort of like a huge multi-dimensional jigsaw puzzle. So I really got into genetics completely by accident, I discovered biology at the end of high school, had a wonderful teacher but I didn't like biology. It was so full of stuff and no periodic table so it didn't seem like there was any kind of framework to hang it on and it wasn't till I came across evolution much later that I found that that is really the periodic table of genetics.

I thought genetics was all about breeding budgerigars and so it was a few years later that I discovered the molecules of life, DNA and the framework on which to hang all this information. So it's been a fantastic career and really life in the lab, yes there are disappointments and there are Eureka moments and there are moments of tragedy but it's just so fascinating that you can't wait to get to work the next day and start it all over again.

Robyn Williams: James Moody, well known on television, every Wednesday at 8 well most Wednesdays, an engineer who's become a suit. What is your actual job at the moment James Moody?

James Moody: Well at the moment Robyn I'm the Director of Divisional Business Strategy for CSIRO land and water. It's really curious, I was trying to think of what I'd call myself now. I'd probably still call myself an engineer more than anything else but maybe I've gone to the dark side a little bit. When I reflect upon what makes me, the thing that drives me is really to solve problems. It's not just asking why, but for me - maybe that is one of the differences between a scientist and an engineer, maybe a scientist asks why and an engineer then uses those answers to try to solve a problem somewhere. But if I look at my family, my father's side of the family they are all engineers and surveyors and that's the Bradfield name and on my mother's side of the family they are all artists and photographers and other things like that. And so I found that I actually find myself jumping between left brain and right brain, wanting to work with things, and I love my technology I'm such a nerd, and then wanting to work with people.

I've been very lucky, when I was young, in fact all my life I've known very much what I was passionate about. If you ask most scientists I don't think is a labour, no it's a love and I think that's where we're getting it, it's because you're so passionate about that. When I was very young, I think maybe it was just watching *Star Wars* just one too many times, but I loved space, everything was about space and I was fortunate that through things at school and through space schools and things I even got to do cosmonaut training in Russia when I was 17 years old and through that it just got me so passionate about this to do with space. And all I wanted to do was solve problems and so building a satellite of course was the best problem to solve for a kid who was really passionate about space.

But then I found that when I was getting more and more passionate about space I'd also look out, look at the stars but then I'd also start looking back at earth and realise that we're just on that one great big earth spaceship and I became very passionate about the environment which is the area I'm following now.

Robyn Williams: Was there any chance during those years that you could have switched to something else? Was it touch and go at any point?

James Moody: No. For example my PhD was actually in a social science area of innovation theory, that's the dark side and the social science is often the hardest things.

Robyn Williams: Jenny, in a word would you have possibly switched to something else at one point?

Jenny Graves: Oh well I started off vowing and declaring I was going to be architect and the only reason for that was at the age of 10 they wanted to know what everybody in the class wanted to be. And all the other little girls said air hostess and I didn't know what I wanted to be but I knew I didn't want to be an air hostess. So I went home and asked my mum and dad well what do I want to be? And they said well you're pretty good at drawing and good at maths so maybe you'd like to be an architect. And I thought oh yeah, how do you spell it and so I was an architect for the next several years until I then won a prize in geography and decided I'd better do something geographical so then I put down meteorologist which I also learnt how to spell. So I really could have been any of those things. In fact I've designed our house a number of years ago and I really had such fun doing that.

Robyn Williams: Barry Marshall you've had a fairly hectic year, what's it been like for you?

Barry Marshall: It's far greater than anybody could possibly imagine to have the Nobel prize for a year. I suppose there's going to be a new Nobel prize winner soon and I think Dr Warren and I will be happy to take a bit of a break.

Robyn Williams: Well with Dr. Warren of course famously from St. Peters where Lawrence Bragg was and Florey was so three Nobel prize winners from one school in Adelaide, they've got something special going on there haven't they, do you know what it might be?

Barry Marshall: I can't say, I really have never been to his school but I think Robin would have always been one of these people who didn't really follow the rest of what was going on and probably tried to do his own thing. And to this day he doesn't really care what other people say or think.

Robyn Williams: Now what about your own origins, did you know you were on an iron path from the age of 4 right through?

Barry Marshall: I'm probably a terrible example. I was born in 1951 and I realise now this was a transition between a kind of mechanical age, the end of the mechanical or industrial revolution and the beginning of the electronics, information and modern technology. So it was a great time to

turn up on the earth because things are changing so much. But my father was a fitter and turner and a sort of a night school educated guy with all kinds of other tickets in the end, caterpillar tractor tickets and marine diesels etc. And my mother was a nurse, so it was a very good combination. And because I always had gadgets, tools, bottles of acetylene, arc welders, all kinds of other dangerous equipment in the garage I had several brothers and sisters so I didn't have people amusing me all the time, I had to amuse myself. I don't know, I think I just became naturally competent in making things work and that generated an interest in solving problems and really I found that once the problem had been solved or I'd figured out how to do it actually bringing the idea to fruition didn't really interest me much after that so I always had many, many unfinished model aeroplanes, boats and junk like that around the place.

Robyn Williams: There's an awful lot of perseverance in science Penny Sackett, what was your perseverance slog or has it always been a dream path?

Penny Sackett: Well about ten years ago a group of us decided that we could imagine a new way to look for planets around other stars and it was using a technique called microlensing that was used in other places in astronomy. And this was just before the first planet around another normal star was actually discovered by a different technique and so some people thought we were absolutely made for even dreaming about finding a planet around another star, a very, very difficult thing to do. But off we set and it was a path that required telescopes all around the world so that you could always have one pointed at the night sky. And in fact, although I wasn't in Australia at that time I was contacting Australian astronomers who were involved in this project. And for ten years that group watched particular stars that were undergoing an effect called microlensing to look to see if the signal indicated that the lens also had a planet orbiting it. And it wasn't until many, many, many years later that we found the first signal and in fact that was found after many planets around other stars were found by a different technique, a technique that's sometimes is called the Doppler effect. And I remember when the first planet was found by the Doppler effect people said to me well don't you feel that you've wasted your time, somebody else found one first? And I have to admit that one does feel a little bit of a deflation when you realise that you had an opportunity to be the first but in fact you weren't.

But when you remember that what you're really trying to do is to understand something and what we were trying to do is understand what sort of planets there might be there, what sorts of stars they might orbit and why, then you realise that there is a huge number of questions and then each of us can probably be first on one of them. And I think that's the thing to remember is that science is full of questions. So persevere we did and in fact at the beginning of this year in 2006 that international collaboration called the Planet Collaboration announced that through its technique, through microlensing it had found the smallest known planet around any star. Which I'm sure will be a record held for some time and then surpassed by someone else. It was a very long slog, ten years, but I can say that ten years ago, even we didn't think that we would be able to find a planet that was just slightly more massive than the earth. It would have seemed like a dream at the time.

The other thing that helps me go forward is that every year there's a new crop of students that come that say they'd like to work with you, there are all these things that they're excited about and you realise that when you begin to explain to them what you're doing and it excites them and it continues to excite year after year the next generation of young people, you think yes, maybe this actually is a pretty blessed life that I'm leading. You know it's like seeing something through your own children's or your niece or nephew's eyes, you realise the things that are really special and in explaining that to others you begin to realise how wonderful it is to even be able to ask questions about whether there are planets around other stars.

Robyn Williams: James Moody your baby was of course the Federation Satellite, did it go straight up in the air on time, no problems?

James Moody: Fedsat did have a slightly troubled birth, this was arguably Australia's first intelligence satellite in 30 years that we'd built. Not many people probably appreciate that Australia was one of the leaders of the space industry way back with Resat and others and then we did have a bit of hiatus and so Fedsat was designed for the centenary of federation for Australia. It was actually originally designed to be launched before the centenary of Federation, the year 2000 on a Japanese rocket a gift from Japan to Australia for our centenary of Federation. But one of the things that was happening was that the rocket launch was slowly getting delayed and that was probably a good thing because the satellite itself sometimes experienced a few setbacks.

Probably the greatest one was when one of our prime subcontractors actually went bankrupt and I had the fascinating experience of actually being there working within this company as an Australian, or one of the two technology transfer agents and a walking user-manual, we had to be part of the group that effectively brought everything back to Australia and rebuild the team and did it just down the road here. So there are moments in that when you can get very despondent, you can get very you know this was never going to happen, how could we possibly do it, but I often find you know nothing is really that bad. It's either a learning opportunity or if it goes well it's great, if it doesn't it's a learning opportunity and you try the next thing. And you know ultimately there's a whole lot of technology that was transferred to Australia in that process.

Robyn Williams: Is Fedsat still up there?

James Moody: Fedsat is indeed still up there.

Robyn Williams: Blinking at you?

James Moody: Blinking saying hello. We past our three-year milestone last December.

Robyn Williams: Excellent. Jenny what about your preference?

Jenny Graves: My honours year in 1960 whatever it was I was trying to get to the bottom of why the X chromosome in females, one X chromosome is completely inactivated. And I'm still working on that and it's taken something like 12 years looking for a particular gene and it turns out it's not there. Now actually we've been suspicious that it's not there in kangaroos for a long time but it's very hard to show that something really isn't there because referees will always say well you haven't looked hard enough. So that's been an extremely long and frustrating search which is I think is coming to the end but just last month somebody else in France published the paper that we were going to publish. So after all those years, and this sort of thing happens all the time.

Robyn Williams: How do you feel about that?

Jenny Graves: Well it doesn't bother me as much as it bothers the young people in my lab because I guess I'm a tough old thing these days and I guess also like Penny, I have a lot of different projects on the boil all the time so there's always something going well and there's something that's collapsed in a heap, and then something that's going along, so it really helps to have a number of things that can make you feel happy when you're likely to jump out of the window. I've never been completely devoted to just one project and so that really helps, it's a bit of an insurance against a bleak depression. But I guess I'm just a naturally very optimistic person and I really wonder how anybody could be a scientist who isn't naturally optimistic. I mean you get so many knock-backs, you get knock-backs and peer review, every time you turn around you are getting the money to do the experiments in the first place, reviewed regularly to make sure you're doing the right thing with the public money and then you submit the paper and you get knocked on the head again. So you have to be extremely sure that you're doing something interesting and worthwhile and I think you do need some natural optimism and I have a ton of that.

Robyn Williams: Before you put off everyone at home it is worthwhile, there are pay offs, there's a huge reward..

Jenny Graves: There's a huge reward but perseverance is a quality that I look for in students because you know you can be the smartest person in the world but if you can't stick it for a few months or a few years you're never going to be effective. And I've had students who are way smarter than me but I know right away they're not going to be effective scientists cause they just can't stick it.

James Moody: I'm just going to say I have an interesting theory around job satisfaction and I've never really been able to test it but my theory is that job satisfaction and creativity are very much linked. And one of the things that if we're looking at the positive sides of what science is all about of course you will have setbacks and I think setbacks occur in any creative process be it science or painting or whatever it might be. But at the end of the day the ability to say I solved that, I made that, I worked that out is so much more rewarding than I made this house, or I made this car. You know the only other sort of creativity I think you can get if you're earning money.

Robyn Williams: Barry Marshall I remember was it the 80s or early 90s, probably the 80s I got a television clip from America about the guy called Barry Marshall who had persevered with his idea and was in the process of being proved right. America seemed to note that you were on track before perhaps the rest of the world. Is that right?

Barry Marshall: Well the issue is that in Perth particularly and probably Australia is still rather small country numerically and so that as you become more specialised it's very easy to outgrow your peers. Where we were nobody was looking at the combination of microbiology and ulcers, stomach ulcers and the same. I know none of you can remember what we did, we discovered the germs that cause ulcers.

Robyn Williams: Everyone can remember what you did.

Barry Marshall: I don't count on it but there was nobody who was really a microbiologist and a pathologist and a gastroenterologist who could really synthesise what we had put together and so there are only five people probably in the world that could say to us this looks like it could be important or not, who knew enough. And so it was much more appropriate to be you know fighting the battle over in America or in Europe than in Australia because in Australia all people could say was oh, this bloke in America says that it's a load of rubbish. You know you couldn't really get your own opinion in Australia, there wasn't anybody at that level. So it was an interesting battle and any time you have a bit of new knowledge it's very weird that you get such a reward out of getting a paper published.

Robyn Williams: But what about that new knowledge? Jenny you're nodding your head, whether someone else in Italy is first by half an hour or whatever, both of you have seen something that no one else in the history of the world has noticed.

Jenny Graves: Well I think you've put your finger on what's so exciting and in fact it can be something reasonably trivial that can give you a tremendous kick. You'll be walking along around the lake and suddenly you'll think I know why turtles have got no Z chromosome and suddenly know that. And this is long before you've even done the experiments let alone written the paper but you get such a tremendous charge out of having figured it out.

Robyn Williams: Whether it's some knowledge about microbiology or whether it's the work of a satellite or maybe the Z chromosome in the turtle, you never quite know what it's going to lead to. James is that the sort of hope that you live in that one small thing that you do might lead to all sorts of avenues?

James Moody: I think absolutely. It's really interesting; now we're deciding to talk about innovation which of course is the idea plus the application of that idea. Sometimes you could actually say that ideas are cheap you know what I mean, that you can have a lot of them but it's the perseverance to be able to actually take those ideas and then use them to make a difference. You know everything I guess I do in my life is all about trying to make a difference and the things that I'm passionate about but for me the real path towards that is about innovation. It's about taking that idea and then having the perseverance and having the ability to see it to fruition, does somebody actually buy it, or use it, or say that's great, or change the world, or help the environment. Whatever it might be that you're doing.

Robyn Williams: Yes, well Barry Marshall were you perfectly clear from the beginning when you found helicobacter, these germs associated with ulcers, that there could be the basis of a cure here?

Barry Marshall: Well once we realised that these could be the cause of ulcers then it was important to find out if it was really true because the second part of the equation is that you could cure ulcers with antibiotics and you didn't have to worry about all those weird things like stress. I used to see those poor patients, they'd give up their jobs, sell their business, go on holidays, stop smoking and they'd be doubly miserable and they'd still have their ulcers. But one of the side-issues was that there were people, many people who made a living for 30 or 40 years treating stress and publishing books on stress and in New York there's the Stress Institute and it was all related to emotional stress causing physical disease particularly ulcers. And so this issue of studying something for a number of years and then finding out that it was all wasted; these people seemed to have an incredible coping mechanism but the problem was that they had a hypothesis which nobody could test. And so that once we had our theory we had hypotheses every day and most of these hypotheses could be tested very quickly in a few weeks or months so although it's a long process and it took years etc. every week, or every month, we had some incremental advance which said yes, you're still going on the right way. As if like a blind person with a cane is sort of going to one side of the path and tapping and says that's the edge and then heading back the other way and eventually getting there.

Robyn Williams: We're listening to *The Science Show* on ABC Radio National coming from the National Science Week in the Academy of Science building and talking about what's beyond the breakthrough, the people who grew up in a certain way and chose science and persevered and eventually got the wonderful pay off. Can you say each of you briefly why someone who's young and listening at home, one of those 20,000 the minister for science and education might want in the next five years to join up your ranks - Penny why should they choose a career in science?

Penny Sackett: I think two reasons come immediately to mind. One I would say is because it is I suppose I can say fun. Fulfilling maybe is the word I would really want to use, it's fulfilling. So if I use an example from my own discipline why should it be that one human being on this small planet could imagine and occasionally even get right how something works on the other side of the universe? Why is it that the other side of the universe, even obeys the same rules of physics and science as we have here on Earth. When you think about it that's already an amazing statement. And the second amazing statement is that somebody that's in school right now will discover even something more amazing about the universe than we now know. So I think that's one reason.

And the second reason is the world needs you. I think that as we can see in our daily lives year after year that more and more we rely on people that can give reasonable considered answers that are curious and that can help us solve some of the challenges that we will have as a society going forward. So it's fulfilling, you have a chance to do something that very few others will have done up to that point and the world needs you.

Robyn Williams: Jenny same question.

Jenny Graves: I guess I go even further and harken back to something Penny said to begin with which is that all young children are so curious about the world and how it works and I would call that science. And I would just love to encourage young kids to keep on being curious, take your curiosity to new heights and I wish that our education system was sufficiently advanced to encourage that curiosity because I think that natural curiosity that kids have is what we enjoy as scientists. Both the breadth of it - I mean you can do anything, the world is so huge the opportunities are so enormous and you're so unlimited in what you can do. I guess one of the saddest experiences of my life was when I was a student advisor and I sat there giving out advice to students who came and one young lady with an excellent record came by and said, I want to enrol in podiatry. So I said oh, are you interested in feet? And she said feet? And I said well if you don't know what podiatry is why do you want to do it. And she

said my careers teacher told me it's easy and you earn a lot of money.

Robyn Williams: Ahhh.

Jenny Graves: And I just for ever have wondered whether she stuck with feet and earned a lot of money or whether she discovered that the world is much bigger and grander and more wonderful than that.

Robyn Williams: James Moody I'm 20, I want to earn a hundred thousand bucks when I'm 22 and so I'm going to go into commerce. Persuade me to go into science.

James Moody: I would say that the best thing about science is that it gives you an amazing tool kit, an amazing way of thinking where you can break down problems and you can solve them and amazing opportunities to pretty much anywhere that you want. So really if you're passionate about a particular field, be it automotive, or space, or feet, or whatever it might be you can actually do things in that field and you can make a difference and you can make change. And curiously if you look at some of the large consulting firms, they love scientists, they love engineers because they get taught analytical skills on how to think, how to break down problems and how to do models and so really the point for me is not just about making a difference and it's not just about being able to solve problems or being able to follow your curiosity wherever it may take you. But it's also about opening doors.

Robyn Williams: Barry Marshall what would you tell them.

Barry Marshall: Oh well I'd encourage people to do what they are interested in because even though you might not see a career path in it right now if you're interested in something there's probably a million other people out there who are interested in exactly the same thing. And the example I thought of today was when cell phones came out everybody was saying well it's just a phone, get real, but there are now people who make millions of dollars composing ring tones for cell phones. I mean who could have imagined that business would ever exist so most of our children our grandchildren are going to be in careers that don't even exist now. And you say to the guy in commerce says well I might go into commerce and earn a hundred thousand a year that's nice, but I would say well wouldn't it be nice to actually discover something and have a company that was worth a hundred million. That's not going to happen in commerce but it could happen quite easily in biotechnology or something. And if you look at the profits coming out each year from different companies, you see Western Mining with billions of dollars of investment and thousands of people and trucks and they make a profit like ten million dollars a quarter, or fifty million dollars a quarter and then you go to San Francisco and there's a little company that's just around the corner from you in a nice little building and you find out that they actually make 300 million dollars a month licensing something - Dolby Laboratories would be an example. The scale of it is just different.

Robyn Williams: Questions - yes.

Question from the audience: As a mature age student I've just started a science course at the University of Canberra and out of 119 of us I was surprised to find that 84 of the students are female which rather surprised me cause I had presumed that science was more a male-dominated society. I'd be interested to hear what the panels experience were when they were undergraduate as to what the ratio was and why they might think that women are becoming more involved, or interested in science?

Robyn Williams: Jenny.

Jenny Graves: Well I was a student during the 60s and I did sort of the hard sciences, physical, inorganic chemistry and statistics and I was I think one of three women in a class of 50 or 100 in chemistry. So I was very much in the minority and I'm sure you wouldn't find that today. I don't know how many committees I've been on to make life easier for women, it still is not easy, I mean it's so difficult when you have a young family to still be a serious scientist. You need perseverance times about 100 if you're a woman with a family pursuing a scientific career. So sure, I think there's a lot of women entering the profession as students and I really hope that we can find some way that they'll become successful scientists.

Robyn Williams: I still boggle at Dr Fiona Woods' achievements, Australian of the year, working on that spray on skin, she's got 6 children. Penny.

Penny Sackett: My journey, what I would like to see now is that that now moves through into positions of more stature, it involves women moving through to choose it for their career, not only for study. And that we create a framework that makes it easier for them to do that and at the same time makes the working environment better for all the men that are there as well. And so that if there are questions about raising a family and having a career in science that both the men and the women that choose that path will benefit if we can create an environment that makes that more acceptable.

Robyn Williams: Next question - yes.

Question from the audience: It was asked earlier why should a person be a scientist, but where should someone go to actually find out what kind of scientist they want to be? I'm coming up to university, I've always been interested in science but I don't have a clue what kind of field I want to go into.

Robyn Williams: Work experience - Penny.

Penny Sackett: I don't think you have to choose, I think it's far too early to choose and I think often the profession will choose you. I think what's important is that you follow what most interests you. I'm doing something now that has absolutely nothing to do with what I got my PhD in, you know I had to study a lot of years to get a PhD and my PhD is in quantum chromo dynamics, what I do now has nothing to do with that literally as a subject matter. But what I'd learned, the skills I learned, the toolbox that we were hearing about earlier is always with me. I take that with me and I use that in ways that are sometimes quite unexpected. So my advice to you would be just to study the things that interest you, talk to people, find out what they do and not be overly worried just at the moment about what profession you will be doing several years from now.

Robyn Williams: The question however is where do you go, if you actually want to find out what people do, can you just knock on the door of the CSIRO in Canberra or in Perth and say look I've come to play for a few days to find out whether you do anything other than tap your keyboards, look at your screens or answer phones?

James Bradfield Moody: I talked to some students who did that about two weeks ago. That's not necessarily the path - I've got a good friend who I remember in my final year of school, when he came round to choose his university course he basically just talked to the teacher, what should I do, yeah commerce, that sounds great, put it down. About a year into that degree he actually then changed, decided he didn't want to do it at all. So I think the point is to invest your time into talking to people, family, friends whoever it might be, you know knock on doors, be audacious, I think audacity is also the thing if you need to, but also remember that innovation happens at the boundaries and if you do make a wrong turn, that could be the one thing that makes you different to everybody else. And so it never really is a wrong turn, I think some of the things I've done, electrical engineering is helping me in the environmental domain, it's quite amazing.

Robyn Williams: Would it not be practical however for either young people at school, or certainly at university to be able to spend a week with an outfit somewhere, a museum, marine scientists, CSIRO whatever, just to do something on the job to see what it's like.

Jenny Graves: Most universities have work study programs, we have a lot of young students. Almost nobody will reject a young person who evinces interest in their field so you know knocking on doors usually works.

Robyn Williams: Another question here.

Question from the audience: I'd just like to raise the question as to how you safeguard the honesty and integrity of our output and sort of avoid oh horror, that catastrophe of instances in Australia's past of fraud.

Robyn Williams: Not least in South Korea recently on stem cells.

Barry Marshall: The secret is that there has to be some investment into an audit process that continually does peer review and actually looks at things. I was always very paranoid about this and in my garage I've still got a box with my first 100 patients, their actual questionnaires if you want to come and look at it. I suppose it'll be in the archives one day, so I've always been ready for that. The situation I think in Korea was that they had the rewards coming out to the scientists before they actually accomplished the feat. And this industry built up around a projected success story which then became 99% hype and they couldn't really bail out at that point. There were too many people in the business of making a living off the hype associated with the stem cell thing in Korea. So it's got back into the real world now and there were plenty of good of scientists in Korea who are still working on stem cells.

Robyn Williams: Barry of course most of science has to be reproduced even if there's a star that needs to be seen. You say it's over there and someone else takes a look. Can there be science that is fraudulent which lasts more than a couple of years? I know you can have frauds in other fields which last almost forever but in science can they last much?

Barry Marshall: I've seen that when they do last it's either inconsequential results that nobody could care about anyway and couldn't be bothered repeating. Or something that was so difficult to do nobody else had any resources to do it. And so it's a limited number of experiments that can be like that.

Penny Sackett: Ultimately what scientists care about is finding the truth. So if they're engaged in fraud at some point they're not scientists. That's not to say it doesn't happen of course, because we're not saints, but the process of doing science should correct that. Because results are expected to be reproducible, because you're expected to open up to tell everyone exactly what you did, you must share everything in science to explain how

you were able to do it so that the next person can do it. And so I think it would be very hard to devise a system where fraud would be impossible but I think we have a system where fraud is reasonably rare and it can be corrected.

Jenny Graves: But I'm very concerned about the way that we train young scientists in high school and in undergraduate practical classes where we give them exercises where there is a right answer and they just have to go and find the right answer. And if there's a straight line they'll get a straight line. I think we should be much more wary of that kind of training and instead have the kind of exercise where there is no right answer and where the students are expected to do good work and make their own observations rather than draw a straight line first and the points after it. So I think really we should think very much harder about how to train students to use their own eyes and use their own brains and not to have the answer in the text book.

Question from the audience: I just wanted to simply stress that I think it's very, very important that young people pursue their passion. I speak from my own life's experience and I finished high school in 1953, I was passionate about mathematics and I had a passionate school councillor who said I mustn't do mathematics, it was ridiculous for me to think about that. I could do anything I wished to do, my academic results were good. Do law, do medicine but I didn't want to do law and I didn't want to do medicine and I found myself going into a sort of limbo and I ended up in a profession. But I have really been sad and regretful all my life about not having pursued my passion and now I'm making it a mission in my latter years to stress to young people if they really feel they want to pursue a particular subject, take hold of it and don't let hold of it, whatever other people say.

Robyn Williams: Thank you very much I'll take that as a statement and a final point.

Question from the audience: I guess one of the things that keeps scientists going is there's always more to know. So for each of you what's the next big thing that you want to know?

Robyn Williams: Penny.

Penny Sackett: I'd like to really understand how planets form and how it is that seemingly small differences can make them then evolve into things that are quite different indeed. We don't really understand how planets form, we have some ideas and when we get to the hard bits we sort of say - and then a miracle happens, and we go to the next bit you know. I mean there are some bits that are very, very hard to completely understand. But even if we knew that we'd then have to ask why it is that some stars we now know have planets that seem entirely different than our own solar system. Why? We might have thought that we were typical, and perhaps it is rather common but we certainly know that there are things that are very unlike it and we don't know why. And I think that's a big origins question, that's a question that human beings really need to understand. Why is it that the earth is just one out of a tremendous example of planets that conform? It's a lifetime of work but it's probably the next lifetime of work, it's probably something that we can now start and will be finished in a lifetime.

Robyn Williams: Penny thank you, we'll take these as last statements. I don't think you were supposed to say and then a miracle happens in the Academy of Science in Canberra. Jenny your next big thing.

Jenny Graves: Well I have some very specific things that I want to do in the next few years. I want to finish working on the genomes of the kangaroo and the platypus because incredible amounts of information are going to come out of that. As specifically I want to understand how the X chromosome gets inactivated in kangaroos although it doesn't seem to have the gene that supposedly controls this inactivation. I want to know how sex chromosomes evolved and how they work and we keep thinking we're near the answer but it keeps on getting more and more complicated and further away. In the long-term I'd really like to understand how evolution works, how this sort of undirected mutation can produce creatures that work. I mean we know now that it's not any kind of intelligent design but it's more a question of accidents that happened a long time ago and which you have to compensate for. And so it's immensely complicated process that this extremely simple idea and I guess I'd really like to get that idea across particularly to young people that nature is incredibly rich and varied and it's changing all the time and it's much more wonderful than it would be if you just sort of had a miracle and had it happen.

James Bradfield Moody: For me the real thing that I want to know is probably not as much in terms of the scientific field but it's more about how can we end poverty? Because unless we end poverty we can't stop fighting and thought for me is the real fight which is how can we sustain life on earth and really this wonderful thing called the human being. But the real thing about that is going beyond short-terminism.

Robyn Williams: Barry Marshall where do you go after a Nobel prize? I know Fred Sanger has got two Nobel prizes, is that your ambition?

Barry Marshall: That's a secret ambition of all Nobel Laureates I'm afraid and some statisticians would say actually that the odds are quite good because it's like four out of 300 versus I don't know, one in a billion. My interest at the moment is to use the helicobacter organism which lives in your stomach for your whole life, it's really almost like an organ grafted onto your body in some respects. To use that for something useful like vaccines or delivering drugs, pharmaceuticals through the wall of the stomach. So my immediate short-term benefit is one of these papers in

Nature where you see a great big fat mouse and a little skinny mouse and one of them has got the new drug delivery system and if you want to be fat or skinny then you can use that.

Robyn Williams: Very ambitious. Well we've talked about beyond the genome, we've got somewhere up the path, thank you for coming and would you thank the panel.

Nobel Prize winner Barry Marshall from Perth with Professor Jenny Graves of the ANU, Penny Sackett of Mount Stromlo Observatory and James Bradfield Moody of CSIRO. On next week's *Science Show* we take a holiday in space. I'm Robyn Williams.

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Producer

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Saturdays 12.10pm
repeated **Mondays 7.10pm**
Presented by
Robyn Williams

In This Program

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