**Inspiring Queensland STEM professionals podcast series**

**Professor Ian Frazer**

*Professor Ian Frazer is a clinician scientist, trained as a clinical immunologist in Scotland. As a professor at the University of Queensland, he leads a research group working at Translational Research Institute (TRI) in Brisbane, Australia, on the immunobiology of epithelial cancers. He is recognised as co-inventor of the technology enabling the HPV vaccines, currently used worldwide to help prevent cervical cancer. He heads a biotechnology company, Jingang Medicine (Aus) Pty Ltd, working on new vaccine technologies, and is a board member of several companies and not-for-profit organisations. He was the inaugural president of the Australian Academy of Health and Medical Sciences, an Australian Academy of Sciences Fellow and a member of the Australian National Science and Technology Council. He chairs the Australian Medical Research Advisory Board of the Medical Research Future Fund. He was recognised as Australian of the Year in 2006. He was recipient of the Prime Minister’s Prize for Science, and of the Balzan Prize, in 2008, and was elected Fellow of the Royal Society of London in 2012. He was appointed Companion of the Order of Australia in the Queen’s Birthday Honours list in 2013.*

**Announcer:**This is a Queensland Department of Education podcast.

**Speaker 1:**
Today, Dr Terri Burnet has a chat with Professor Ian Frazer, who is a clinician scientist trained as a clinical immunologist in Scotland. As a professor at the University of Queensland, he leads a research group working at the Translational Research Institute in Brisbane, Australia, on the immunobiology of epithelial cancers. He is recognised as co-inventor of the technology enabling HPV vaccines, currently used worldwide to help prevent cervical cancer.

**Dr Terri Burnet:**
Good afternoon, Professor Frazer, and thanks so much for your valuable time. Let's discuss the recent exciting news in relation to a vaccine for COVID-19, developed by your colleagues at UQ, that is now entering human clinical phase one trials. Tell us about the vaccine and how its development has been a collaborative effort.

**Professor Ian Frazer:**
The vaccine is an attempt to make something to help protect against the virus that causes COVID-19. It uses state of the art technology developed at the University of Queensland. There's a so-called clamp technique to enable the production of a little bit of the virus that's not infectious, but has the right appearance to the immune system, so that it raises protection against the real virus when it's encountered.

Of course, at the moment, we have evidence that this is working in animals and produces the right sort of immune response, but we don't yet know whether it will be effective in patients to protect them against the disease. The clinical trials, we hope, will reveal this over the course of the next few months.

**Dr Terri Burnet:**
So, there's nearly a dozen vaccines in clinical trials around the world at the moment. Human trials have just commenced in Perth for a vaccine developed by the British and Chinese scientists. Why are there so many groups worldwide working on vaccines separately?

**Professor Ian Frazer:**
Look, first of all, we have to recognize that there are many different technologies that we now have at our disposal for making vaccines. We can make vaccines using virus which has been killed and rendered safe. We can make vaccines using live virus which has been made less likely to cause disease, but still spark off an immune response. We can make vaccines using DNA, RNA, and protein. And each of these will have different characteristics and will likely have quite different efficacy when put into the clinic.

So, it's important that we use as many technologies as we can to develop a vaccine because we really need a vaccine quickly to control this current pandemic that's going on of what in fact is a rather nasty infection. We don't know which technology will work best. There is no prior reason to believe that one will work better than another. So, it's important that we try every possible combination of technologies to get to the best possible vaccine.

**Dr Terri Burnet:**
So every year, most of us are infected with a coronavirus by way of just the common cold. How is the COVID-19 coronavirus different and why is its impact on society so much more devastating?

**Professor Ian Frazer:**
Well, coronaviruses have been around for a long time and some of them cause quite serious illnesses. This is the third in a series of coronaviruses which cause serious illness in humans. Different coronaviruses infect the body in slightly different ways and the current virus that's causing the problem infects the lung lining cells in such a way that the cells are killed by the virus and that leads to pneumonia in the lungs. The virus can then also spread further in the body as a result of the damage it does in the lungs, to cause problems in the blood vessels and other major organs.

Fortunately, the coronaviruses we've had up till date, with the exclusion of SARS and MERS, have been limited to infecting the nose and the upper respiratory tract, which basically gives us a common cold. But these viruses have adapted in a way that allows them to spread more effectively in the body, and from the point of view of the virus, therefore, produce more extra virus, but from our point of view gives us pneumonia and other serious illnesses.

What we've learned from the other coronaviruses is more importantly that the viruses themselves are not particularly good at invoking an immune response and they don't give long-term protection, which is why we get colds quite regularly. We have to hope that we can do better with a vaccine for the COVID-19 causing virus than we would see with the normal common cold viruses, which don't produce good long-term protective immunity.

**Dr Terri Burnet:**
Could a vaccine be distributed using the vaccine patch technology, which has had recent trial success, rather than expensive needles that require refrigeration?

**Professor Ian Frazer:**
Well, that's to be determined. The Nanopatch technology is certainly one possible way of delivering a vaccine. It has the advantage that it doesn't need a needle and syringe. It also has some advantages in terms of the need for cold chain and keeping the vaccine cold. But, yes, it's technology that hasn't been proven for widespread use in humans and therefore it's quite important to keep that in the background as a possibility of the way that we distribute the vaccine.

Really, the most important thing for us at the moment is to decide which vaccine will work and then work out a way of scaling up production to produce enough to immunise nine billion people across the planet to protect them against this virus. And it's the scaling up for production that's going to be the challenge that we face over the next year. Delivery systems will be important. And the nice thing about the Nanoneedle patch is that it brings with it its own ability to stir up the immune system to get a better immune response. But exactly which delivery technology will best fit the vaccine that becomes the best candidate for protection will be determined by the nature of that candidate and different vaccines will require different delivery systems.

**Dr Terri Burnet:**
Let's talk about you now. You were born in Glasgow in Scotland and studied in Edinburgh before first coming to Australia in 1974. Both of your parents were scientists. Share some of your experiences growing up, particularly what first triggered your interest in STEM. And did your parents impact on your decision to pursue a STEM based career?

**Professor Ian Frazer:**
Well, of course the term STEM had not been invented when I was a student. It's a modern acronym, but both of my parents were scientists and I think that they probably wanted to encourage me to take an interest in that area. They didn't really need to work very hard in that. I was also, as a child, rather curious about how things worked, and liked to take them to bits to see how they worked and put them back together again to see if I could make them work again. But they chose toys for me, I guess, when I was a kid. I got a chemistry set when I was about eight years old and that was fun. They're not allowed to make chemistry sets like that anymore, but it certainly encouraged me to experiment. I was also given a telescope. My father was quite keen as an amateur radio person and I learned how to build and make radios for myself, starting with a crystal set and then moving onto valves, which we don't use anymore.

So, as a child I had a lot of experience in the subjects which would now be regarded as STEM subjects. And they were the ones I chose to study when I was at school too. When I got to high school they were much more interesting to me than perhaps learning history or geography. But I probably should have learned the history and geography as well because they are equally important. I don't wish to belittle other areas of study, but science was what grabbed me.

**Dr Terri Burnet:**
You and Doctor Zhou developed the world's first vaccine against cervical cancer, Gardasil. It's now licensed for use in 121 countries worldwide. Tell us about what led to the discovery of this vaccine and how does it feel as a scientist to be able to successfully impact on so many people's lives?

**Professor Ian Frazer:**Look, the discovery of the vaccine was almost accidental. We were interested in this virus which causes cervical cancer, and we wanted to understand better how the virus worked as a virus. And unfortunately, it was not possible to grow the virus in the laboratory, which is unusual because most viruses can be grown in the laboratory. So that in order to work on the virus, we actually had to make a virus in the laboratory and we did that using what was then a new technology called recombinant DNA technology to express the various bits of the virus in the lab. The first bit that we wanted to make was the shell of the virus and it was basically 360 copies of one particular protein. We could make the protein relatively easily, but to get the protein to assemble into the shell of the virus was a challenge that took about a year of work to find a way of doing that.

But the really interesting thing and why the vaccine became possible was because when we eventually stumbled on a way of making the bits assemble, they actually chose to do that all by themselves. So long as we made the protein the right way, the bits assembled to make the shell of the virus. And when we saw the shell of the virus there, I recognised that if there was going to be a vaccine against this virus, that would be how the vaccine would be made, since the other ways of making vaccines that were available at that time couldn't be done, since we couldn't grow the virus in the lab. So, we had the technology, if you like, which enabled us to make the shell of the virus and that became the basis of the vaccines which are now available.

When we did that, we didn't know how there would ever be a vaccine. We didn't even really know if there was a strong enough need for a vaccine at that time, because the connection between cervical cancer and papilloma virus infection was a relatively recent one made by Harald zur Hausen and his colleagues in Germany. And it wasn't clear, at that time, how much of cervical cancer was caused by the virus, and how common the virus infection was in the community, and whether there were other things that were necessary in order to get the cancer.

But as it turned out, the infection with the virus was extremely common. The cancers were 100% caused by the virus infection, although most of people who got the virus never got the cancers. And there was really nothing else that anybody could point to apart from persisting virus infection that actually led to the development of cancer. So, that set up a situation where a vaccine was obviously going to be the best way to prevent cervical cancer. And that was when the various companies that had been involved in developing the product that we had through to the point where it actually could be used as a product out in the field, they got interested at that time and took our technology and turned it into a vaccine over a fairly lengthy period of time.

**Dr Terri Burnet:**
At the Translational Research Institute in Brisbane, you lead the development of a world leading biomedical research facility. There is research taking place into a whole range of diagnostics and treatments through TRI in conjunction with multiple partners. Tell us about how this research has been driven by the needs of society.

**Professor Ian Frazer:**
The Translational Research Institute was set up to ensure that scientists who came up with ideas and results that might be practically useful in health, got the opportunity to work with doctors who could guide them to steer a product out to the clinic. One of the challenges that's always been true in science is that we're not that effective at working out which of the things we discover can be turned into a product that's useful. And the best way to make sure that that happens is to have this juxtaposition between doctors and healthcare professionals who know what the problems are, and scientists who can come up with solutions which might or might not be relevant. But if you get the scientist and the doctor together, they can work out what's going to be most useful.

And really, that is why TRI exists and why it's actually working, because of that intermingling of scientists and doctors together, and the common discussions that go on about the problems that doctors face, the solutions that the scientists might have and their general utility. And also, once the doctor gets excited about a possible solution to a problem, they're going to be the ones that will drive the thing into the clinic and make sure that it can be used.

**Dr Terri Burnet:**
The focus is on COVID-19 at the moment, but there are also so many other scientific challenges facing the world. How critical is STEM education for our children?

**Professor Ian Frazer:**
Look, I think that every child should get a STEM education to the best of their ability because STEM subjects basically underlie the way the world works. We do through experimentation, define problems and solutions to problems otherwise we would have to guess. So, the STEM technologies are actually quite important in driving rigorous approaches to human problems.

These are exemplified obviously by vaccines like the vaccine we are trying to see developed for COVID-19. But equally, the ability of mathematicians to work across a set of data, to come up with solution by observation, and then to prove them using mathematical technologies. Engineering, critically important to deliver the outcomes from that. So, the vaccines that are made to prevent cervical cancer required an engineering solution as much as they required a biological solution in order to get the technology to work. And each of these individual subjects in the science and technology spectrum contribute usefully to society. So, people who want to work in these areas will need the STEM skills to get there. But even people who don't work in those areas need to understand the practical importance of STEM in enabling them to understand how things happen.
 **Dr Terri Burnet:**
Do you think the community's perception of the importance of STEM education will change as a result of all the impacts of COVID-19?
 **Professor Ian Frazer:**
Look, I think that many people in society are very happy to see that STEM delivers the goods without worrying too much about how it goes about it. But I think it's important that every time we come up with a solution through research, whether that's an engineering solution, a science solution, a mathematics solution that we say loudly: "This came about because of people having had a STEM education."

People otherwise take all the technology for granted. Everybody in the world virtually has a mobile phone, but very few of them realise that that rose out of 50 years of research, which eventually led to the miniaturisation of the technologies that lie inside a mobile phone and which no individual person on this planet could probably reproduce right now. It would take the sum total of many people to recreate the technology that leads to mobile phones working.

**Dr Terri Burnet:**
In 2007, you were instrumental in the establishment of SPARQ-ed (Students Performing Advanced Research Queensland). The SPARQ-ed facility, located in TRI beside the Princess Alexandra Hospital, is a collaboration between the Department of Education and UQ. Why did you establish this facility, Professor Frazer?

**Professor Ian Frazer:**
At the time, we were very keen to let students in high school, who were doing science subjects, understand that the science actually led to practical outcomes. And so, we wanted to have an environment where the students could come into a real science lab, work with real scientists and see their own work contributing usefully to the science work that was being done. These weren't potted experiments, this was real discovery science.

And we realised that to excite students about STEM subjects, it was important to get them involved in the real discovery stuff as early as possible. It's important that they learn the basics through the way that we teach science at the moment, but it's equally important that they understand how exciting it can be to be in the discovery phase of science, where something new comes out of the work that they as individual students were doing. That's always been the philosophy behind the SPARQ-ed facility, real scientists meeting up with the high school students to make sure that they can actually get their hands dirty in real scientific experiments.

**Dr Terri Burnet:**
As an enthusiastic and passionate advocate for STEM education, what advice would you have for students interested in pursuing a STEM based career?

**Professor Ian Frazer:**
Just do it, that's really the most important advice. The important thing also is to talk with real scientists, real mathematicians, real engineers, about what they do and find out how interesting it is. It was the discussions that I had with the scientists that my father knew and with people that I bumped into when I was in high school, who were working in the science environment that spurred me on to take a career in science. I went to university to study medicine, and I was very glad that I got the opportunity to do that, but I was always the scientist as well as the clinician and wanted to make sure that I could use my science to advance medicine rather than just delivering service as a clinician.

**Dr Terri Burnet:**
Thanks so much for chatting with us this afternoon, Professor Frazer.

**Professor Ian Frazer:**
That's been a pleasure talking with you.
**Announcer:**

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