

Marianne de Macy (00:00:00):

Hello, everyone. Welcome to our here at the science exchange for the Adelaide festival of ideas. Just a couple of housekeeping matters to start with. We'd ask that if you have a mobile phone, could you please switch it off or put it on silent for the duration of the session with the bar isn't open today, but there is a water up on the bar that you can help yourself to if you need a drink. And and at the end of this session, we will ask you even if you would like to stay for the next session, we are clearing the auditorium in between sessions. So if you'd like to come back for the next session, we'd love to see you again, but we'll just have to ask you to go back out and join the line and come back in again. And with that, we'll hand over to Marianne who is our host for this afternoon session.

Marianne de Macy (00:00:43):

Hello and welcome everyone to the 2011 Adelaide festival of ideas. I'm so pleased to see so many of you here today. We're turning people away. So well done. I mean, you're obviously intelligent curious individuals because you're here to talk and ask questions and express concerns about three main areas of technology that will affect your future and your children's future. Now, for those of you who don't know, I'm Marianne de Macy, the science reporter well, one of the science reporters on ABC's science program called catalyst, and I'll be facilitating the session for the next couple of well, the next hour or so. So I just want to gauge, does everybody know who they're sitting with on their tables? I'd just give you 10 seconds to turn around and introduce yourself. So the people you're with up there on the top, turn to your left, turn to your right, introduce yourselves, is everybody on the top level?

Marianne de Macy (00:01:36):

Can they hear me now? Yeah, that's better. All right. This is a really great venue to exchange ideas. We're at the science exchange of course, and RAs has been most gracious in hosting us. This is a really rare opportunity for the general public to come face-to-face with scientists to ask the tough questions and to express concerns, because these will be technologies that may or may not affect you in the future. They could be in a good way, or it could be in a bad way. It's up to you to decide today. And as I said, really take advantage of this opportunity to ask the experts, all the questions you can. I want to kick off today by introducing Dr. Stefan Hajkowicz. Is that how you pronounce it? He wouldn't tell me how to pronounce his surname. He wanted to embarrass myself, give me a score out of 10. He's too Hajkowicz is that better? Stefan is the CSS principal scientist at CSRO who likes to think about how people make choices and plan for an uncertain future. So could you please welcome him to the stage?

Stefan Hajkowicz (00:02:54):

Thank you very much. It's really good for me to be back here in Adelaide. I actually spent the early part of my CSRO career working at the CSRO offices near only in a suburb called Glen Osmond. I think it was, which was a fantastic spot. And I lived near the Hague's chocolate factory for quite a while, which has mostly come off. And I love being at the ideas festival. We had a Brisbane ideas festival recently as well, and I had to do a talk there in my elder brother, lives down south, found out about it and Kamia called. And he said, so someone up in Brisbane had an idea. So you had a festival. Got it. Which is I'm sure. No, that was pretty cool, but I'm sure they Adelaide, this festival is not about that. I'm sure there's lots of ideas down here already, and there's no need to celebrate them.

Stefan Hajkowicz (00:03:38):

But it is great to see such a big audience here to talk about science. So I'm on this ministerial advisory panel called nets national enabling technology strategy, and it's a fantastic job. My colleagues are here

today and we have this fantastic job to sit around and think and talk and write about the future of technology, how it's going to change the way Australians live and also what we can do about it to maximize the upside and avoid any risks. So it's a fantastic opportunity I've got on there. And we went for a walk down Gouger street yesterday to see many of the great restaurants that are in Adelaide. Is it true that Adelaide has more restaurants per capita than any other Australian city? I think it is. And better ones too. I really do. I do love eating here. Just not talk about barrels.

Stefan Hajkowicz ([00:04:20](#)):

That's what I've been told to do, not talking about barrels that we'll say seriously though. We were walking down the Gouda street and we found that a Tapper spot, which was a really good one. And we got this discussion going and it lasted most of the night. It was a debate and a fairly one-sided one. I had six versus five versus one. I was the one and we were talking about whether or not a surf board could be considered a form of technology. And I was sure it wasn't. And I would wonder what, who in the audience here would call a surf board technology, if you would put your hand up who would not call a surfboard technology?

Stefan Hajkowicz ([00:04:59](#)):

Well, right, so I'm going to have to have a rethink, but well now I feel a lot more technologically savvy when I get down there and go out for a surf cause that's, that's good. But to me, a surf board wasn't technology nor was a fork nor was a brick. No was a piano that we walked past max. Now that stuff was technology to me. Technology to me is my Blackberry I-pads planes and fancy sorts of stuff. So I'll have to have a bit of a think about what technology is too young. I'm older than I look. So I think my, my view of technology, might've been a popular as to wine informed by my mum. So a while back at Christmas, we bought mum an iPod. She's not really into technology. She opened up the, the packet was started to see what was in there.

Stefan Hajkowicz ([00:05:45](#)):

And she took a pier and see, she looked and said, oh, is it technology? You've got me? And we kind of said, it probably is. And the iPod now sits between the Russian doll and the portrait of the Pope in the in the house and both the Pope and the dog get more use than the icon, but it was interesting to see the effect of technology on it. And as you might've seen, I work at CSI. I've had a fantastic career the last 10 years in CSRO, but I'm a little bit of an odd ball in the organization in that I'm a, I'm a social scientist with severe Luddite tendencies. And Senate would have interesting about where I ended up, but I work amongst thousands of incredibly brainy people who build live and breathe technology. We have flying robots that can go out and fix power poles without anyone knowing about it.

Stefan Hajkowicz ([00:06:28](#)):

We've had another team build invisible fences on farms where the cows know where to walk and they all stay in the right bed. I think a bit secretly they get one or two electric shocks if they wander on the wrong part, but we don't really talk about that part of the technology. It's fantastic stuff about what it can do. So I've had this great journey in CSRO and in CSI, one of my favorite holidays, I mean, work projects was in the cook islands. And this photo behind is showing us Rarotonga in the cook islands, which is a beautiful place where I was put for a month. And the downside of being here was while I was there, we had these massive cyclones four really big cyclones come across in the space of one month. And the I, I was there to work out the economic cost of water pollution, which wasn't related to the

cyclines, but on the arrival of the first night when we had the first cycle and I was staying in a little hotel by the side of the water.

Stefan Hajkowicz ([00:07:22](#)):

And my hotel manager was an old guy, a weather beaten sailor from way back. And he took it very seriously. He bought himself a whole lot of bottles of whiskey and got completely hammered and left me to my own devices. So I bought a lot of tin corn beef instead, which I think did a lot more damage and and some water. And we got through the first cycle. And then there was another one which was category three cycle and Nancy, which was pretty awful. And in New Zealand sent in an evacuation flight to get us all out before the next one came, which was cycling all F which was a category five monster on the map of the whole Pacific. Everything was clouded with a.in the middle, and this was going to be a huge, huge cycling.

Stefan Hajkowicz ([00:08:04](#)):

So this huge plan and came through the air of Boeing 7 47, incredible piece of technology came in and landed on the runway. And it really moved us a lot to, to foot the thought that they had come and found us out there in the Pacific, on this tiny little country at Bailey, you know, stopped before it came off the edge of the runway. Everyone got on, turned around and took off and I kind of missed it. And that's me photographing at going and wondering where I can buy some whiskey that night because I'm in a lot of trouble. But it was an incredible piece why I love the photo though, and what it what it does for me is the juxtaposition of this incredible piece of technology which is worth more than the GDP of the whole cook islands with the simple mud huts behind it.

Stefan Hajkowicz ([00:08:46](#)):

And basic ways of living simple cooking instruments, basic lifestyles, and it is amazing how humans have progressed. I think a Boeing 7 47 and flight jet is an icon of the heat of human capabilities. It's also complex the system that allows this plane to fly safely from Rarotonga to Oakland. It happens again and again it's built upon systems that operate systems that operate other systems that no human being can possibly hope to understand how it works, but every time it comes together and it works and 350 people with all their luggage zoom safely across the ocean at 900 kilometers an hour, and have many kilometers in the sky watching movies and sipping tea. I find it fascinating. What I'd love to do for an experiment would be to get this technology and bring it back 200 years and show it to the first fleet who arrived in Australia, you know, after their year long, something like year long, voyage losing a third or a quarter of their crew to disease and accidents they arrived at after a perilous journey.

Stefan Hajkowicz ([00:09:46](#)):

We'll imagine if you could show them the inside of the Quantas, 83 80 taking that trip with a stop in Singapore, 24 hour trip to get to Brisbane. So I think that is an incredible change we've seen in 200 years. What about the next 200 years? The rate of technological progress has not slowed. It's advanced and it's moving us into new areas. The one that's caught my attention lately and was the one at the Brisbane ideas festival was about telomerase. Okay. This was discovered by Elizabeth Blackburn who won the Nobel prize for it. She's a Tasmanian based scientist, which is a great thing. And she's got the Nobel prize for finding that the enzymes that control the alien aging process in our cells called telomeres. Now they manipulated them in mice and they've got some old mice and made them young again, and they can do it in humans, potentially.

Stefan Hajkowicz ([00:10:34](#)):

Maybe this sort of goes outside my area expertise. So you need to Google this and look it up on Wikipedia to be sure, but I think it means we can all be young and beautiful again, is what I read anyway via the manipulation of telomeres. But I understand there's a downside to the technology and it gives us cancer instead. So don't rush off and get it done straight away. There might be a workaround though. So technology is great, but I don't think we ever escaped being human. Steve Jobs was a brilliant human. He changed the world. We live in and will always be remembered throughout history. His journey was the iPhone, iPod, iPhone iPad. Then I died. Technology can stop that even for someone like him, but there is a flip side. Technology can sometimes hold it off like many here in the audience today.

Stefan Hajkowicz ([00:11:19](#)):

I was a Syrian section birth, and I think the, and my kids were as well. And I think the technology that surrounds C-section, but it's incredible what that medical team did in the Wesley hospital in only 10 minutes, just is something we'll remember for the rest of our lives. And it's really a humbling to think of how technology and those skills came together to give us our children. And everyone has a lot of moments with their children pushing Madeline on the swing, playing soccer with the kids, those sorts of things. Everyone does. These moments don't have anything to do with the technology, but had that technology not existed, they wouldn't there. And nor would I, so technology can make things possible that are intangible and beautiful and not technological. So now I want to hand over to my colleagues to explore where some technologies will take us a question I have is, are we using these technologies to take us where we want to go? Or are they taking us somewhere? Or is it a bit of both? So maybe reflect on that as we see some of the fascinating presentations about new technologies that lie ahead of us. Thank you very much and have a great day.

Speaker 3 ([00:12:25](#)):

[Inaudible]

Marianne de Macy ([00:12:25](#)):

Do you stand for that? Footworking talk. You, didn't made a point about how the rate of technology advancements is increasing. And if we look at a technology 50 years ago and think about how technology will change in the next 50 years, the sky's the limit. It'll be interesting to see how everybody feels about science and technology. You've got clicker pads in front of you. So let's do a quick survey now and we'll compare this survey to how you feel about science and technology at the end of this session and see whether or not you feel more passionate about it, whether you feel more anxious about it or whether or not it's just confirmed your thoughts. So with your clicker pads at the ready, the first question is which of the following three statements best sums up your attitude. Let's get this going, which of the following three statements best sums up your attitude towards the developments in science and technology got 10 seconds to answer. You can register that when you click a pad.

Marianne de Macy ([00:13:35](#)):

Yep. Is it? You want me to read through them? Number one makes science makes a very positive contribution. Science has both positive and negative impacts on society or science largely has a negative impact on society. How do you feel everyone happy with her on some go to the next one? Well, we'll look at the result. Okay. So 60% of you believe that it has both positive and negative impact on society. Many of you believe it has a positive contribution. There's some of you that think it has a negative

impact on society. Oh, I believe that if you want to change your mind, you can just press another number and it will take the last number as your answer. Yeah. All right. Next question.

Marianne de Macy ([00:14:32](#)):

Which best describes your general attitudes towards the potential implications of enabling technologies like biotechnology and nanotechnology. Do you feel excited, hopeful, neutral, concerned, or alarmed? Okay. So look at the work. Ah, hang on. Technology's not great. Is it all right? So about half of us feel hopeful. Many of us are excited. No, one's alarmed about it. There's a few that are concerned. Does anyone want to express some concerns who pressed concerned? Yup. Yup. We've got an expert in nanotechnology coming up on the panel next. So you can address some of those concerns. Let's go to the next question. Who should be the primary decision makers about permitting the use of enabling technologies? Should it be the scientists, should it be regulated by the industry non-government regulate non elected government regulators, elected government regulators.

Marianne de Macy ([00:15:53](#)):

Oops. Did we even vote? Can we go back and start again in the unsure category now if I press forward who's so how so have you cleared the data? Okay. We'll go to the next one. It's technology really is failing us. All right. So that was the last of our questions I believe. Yep. All right. Let's get to the first the first scenario here. This is about regenerative medicine. What we'll have is a two and a half minute video. It will just explain what it's about, and then we'll get an expert panel up on the stage to answer your questions. So if we can cue the video,

Video audio ([00:16:51](#)):

We're all getting old. Yes. Even year one more of our population are over 60, some living well into their nineties. And as we live longer at joints, organs and tissues begin to fail there by diminishing the quality of our old age, not to mention the societal cost of lost productivity and longterm care. Our current medical technologies allow for extraordinary feats of all mentation and replacement transplanted, pacemakers and artificial joints. Regenerative medicine goes further promising the repair of dysfunctional body parts with our own living tissue. Many species can regenerate a salamander can regrow its limbs tail and even its own.

Video audio ([00:17:44](#)):

But sadly only a few bits of us like a healthy liver can perform trick coaxing the rest of our body to do it requires more effort, 3d printed, biomaterial, scaffolds coated with layers of the patient's cells and cooked up in a body mimicking oven can produce viable veins, bladders and bone and more complex organs like kidneys. Aren't far away, adult stem cells while proving difficult to tame promise injectable repairs for conditions like multiple sclerosis type one diabetes, heart disease, and rheumatoid arthritis techniques incorporating nanotechnology are also targeting spinal injuries, joint degeneration, and failing organs, but in the world already burdened with overpopulation. Is it even ethical to invest and encourage extended longevity? Will our culture slow or stagnate without retirement or death of the old guard? Yeah.

Marianne de Macy ([00:18:54](#)):

Whilst our expert panel assembles on the stage, we'll do a quick survey on how people feel about the video that they've watched. So if you get your clicker pads ready, there's a response to whether or not you think that regenerative medicine would likely change the way you live by 2020, or would not likely

change the way you live. So the response, Okay. So many of you Will believe that it would change the way you live by 2020, 47% Wouldn't Keith, would you like to comment?

Dr. Keith McClain ([00:19:31](#)):

Well, I think those those numbers are probably what they've expected. I think there is I mean, as I look at it, I think this is one of the most exciting areas in science at the moment. It's about bringing together people from a whole range of disciplines to tackle clinically relevant and important issues. And it's not just about aging. I think that a lot of what regenerative medicine is about and regenerative medicine comes in many forms, whether it's stem, cell biology or tissue engineering even bringing together biological and pharmaceuticals with devices and things. It's a very, it's a very large area, but I think it's a, it's a very exciting one and it can actually start to tackle diseases that we really don't have a clinical answer for at the moment. And that's what I think is more exciting than the fact that, you know, I might get hip replacement. I can still play golf when I'm 90. I think it's much more exciting to me and people in my team are working on things like methods to help kids with type one diabetes. Can we bring cells together with materials, for instance, implant those in the body and restore the ability to to treat things like type one diabetes. So to me, that's where the real excitement is meeting unmet clinical need.

Marianne de Macy ([00:20:47](#)):

So introduction to you Keith Dr. Keith McClain is the leader theme leader in biomaterials and regenerative medicine at Syros materials, science and engineering. We've also on the panel, got professor Max Lu who has a technical expertise and insight into nanotechnology and biotechnologies, and also professor Sue Dods. She will provide some legal and ethical issues about this type of technology. So let's open the floor now to a discussion about regenerative medicine. Does anybody have any questions to start the discussion of whether he wants to do the front here? We'll just wait for the microphone. We've got a roving microphone

Speaker ([00:21:32](#)):

Timing. Every time you see an announcement about regenerative medicine, it is at least 10 years in the future. This is 2011. So 2020, where, where will we be then? That makes it so different.

Marianne de Macy ([00:21:50](#)):

Keith, would you like to us?

Dr. Keith McClain ([00:21:51](#)):

Very good question. And I mean, you know, there's always a bit of, that's all, there's a lot of hope and hyphen in, in a lot of this stuff that I think we are now starting to see, for instance, in the area of cell therapies, we're now actually starting to see cells being, being applied in a, in a number of early clinical trials. Recently there's been, you know, reports of embryonic stem cells being implanted in the phase one clinical trial by Jeroen in, in the U S people are using stem cells in, in areas like treating macular degeneration. Again, very early stage. I think within Australia, we should be exceptionally proud that we have in visa blast the largest stem cell company in the world using adult stem cells in a number of conditions in phase two and phase three clinical trial.

Dr. Keith McClain ([00:22:37](#)):

So I think there is, there is great hope in, in, in that sort of cellular therapy area. But I think also in other parts of, of regenerative medicine in, in tissue engineering, there are already examples of, of people who are having materials implanted in the body that carry their own, their own cells. For instance there's a recent case of implantation of a material developed in Kings college, in London where the patient's own stem cells being used in a attractional replacement. So there are, there are, there are things coming into the clinic then at the same time, some of the traditional approaches to regenerative medicine you know, around implantable materials for things like hips and things, there's a lot of work going on at the moment to make those materials much more responsive. So 50 years ago, when, when materials first were implanted in the body, you basically wanted something that was in that and that the body didn't respond to it didn't, it didn't it didn't want to sort of wall it off.

Dr. Keith McClain ([00:23:38](#)):

And it basically was there as a mechanical support. Now we're starting to work on materials that actually biological signals, so that if you put that material into the body, you may actually help to recruit cells that will will repair. You may use it to deliver growth factors for instance, or you may use it to deliver small molecules. So I think that is you know, there's always a, a great expectation. Often there is a lot of hype associated with these things, but I think there are definitely there's is definitely progress being made and that things will change in the next few years. I'm pretty sure. So

Marianne de Macy ([00:24:15](#)):

Just picking up on that max, can you describe how sophisticated these scaffoldings they use in regenerative medicine are?

Max Lu ([00:24:24](#)):

Okay. my background is nanotechnology. I'm not an expert in regenerative medicine per se. I think what is exciting to me is the emergence of nanotechnology and also genetic, no human genome and genetic engineering will catalyze or accelerated development of tissue engineering. The promise of tissue to replace the whole body organs has not been realized so far, but the tissue scaffolds built by nanotechnology or enhance the growth of the cells. And therefore also will give you the ability to deliver proteins and other nutrients we, without any infection and also innovating or reducing the immune response. So that's where the nanotechnologies promise is. I think it's always takes time when you want to deliver a new driver or a new a therapy because of the regulatory framework. I think we have the experts and dies in areas. So I think 10 year timeframe in medicine is a very short, I think a lot of the blockbuster drugs came out. It will be after 20 years of continuous discovery and development. So, but nanotechnology has promised to catalyze the OT, a salary thing development.

Speaker ([00:25:44](#)):

Sue, Do you think we'll see changes in regulation of the use of these stem cells in these types of technologies.

Sue Dods ([00:25:49](#)):

Well Diana would be the expert on the regulatory frameworks, but I certainly think that we'll have to ask some questions about whether our existing regulatory frameworks stretch very well into the areas where we've got new ways of integrating devices, like the nano structured scaffolds with our own cells. Because we don't at the moment how much difficulty with recognizing if it takes themselves out of me and you put them back into me, but that doesn't require a specific regulation. But the question about

how we bring these things together would certainly be an issue which might require for the regulation, but Diana May have anything she wants to add to that. Would you like to add something?

Marianne de Macy (00:26:33):

Maybe we'll just wait for the microphone. So the people at the back can hear.

Audience member (00:26:36):

From my perspective what Sue was saying is absolutely correct at the moment these type of applications that are regulated the therapeutic goods administration, which has very distinct classes between what are the therapeutic good and what is the medical device? So when we start to see a blaring between these two categories, that's when we're going to have issues over the effectiveness of such a regulatory framework. So these things are regulated and they will continue to be regulated, but it's how well have these technologies progress. And that just requires our regulators to be acutely aware of what is coming down the R and D pipeline rather than being responsive. When these products are really coming in for assessment.

Marianne de Macy (00:27:17):

is there anyone else that would like to ask a question? We've got one up the top there, Sorry could speak up a bit.

Speaker (00:27:25):

Two basic questions. What are stem cells exactly? How are stem cells derived and how has menstruation blood as a salsa stem cells? Dr. Q?

Dr. Keith McClain (00:27:42):

Well, I'm not, I'm not stem cell biologist, I'm a material scientist. So I'm not an expert in, in, in stem cells, biology per se. So I'm going to be careful about, about what I say all of them. Other than that there are essentially at the moment I think three main sources of stem cells. One is embryonic stem cells, which are derived from early stage blastocyst of of fertilized eggs that are no longer required in the in IVF type treatments. There are adult stem cells, which are found in all tissues of the body, which are small populations of cells, which have a regenerative capacity embryonic stem cells have the ability to basically develop into any any type of of, of tissue cell under the correct conditions. Adult stem cells tend to have limited. They have the ability to regenerate, but then limited, limited numbers of lineages. And recently there's been the development of induced pluripotent cells, whichever essentially differentiated cells like your skin cells or lung cells that can under certain conditions be driven back to an embryonic type state, and then can be driven down a different different lineage. So that is my basic understanding of the, of the different types of sentence stem cells. Your question on that's right.

Dr. Keith McClain (00:29:17):

Well, people are, people are actually have been banking things like port cord blood for a number of years. And there are companies that basically will do that for you, and it is a source of it certainly is a source of stem cells.

Speaker (00:29:33):

So what are some of the ethical issues that we're facing around the use of these stem cells?

Sue Dods ([00:29:40](#)):

Well certainly with embryonic stem cells? There's a considerable ethical debate about both for people who have concerns about destructive use of, of embryos for research. And that's one set of concerns. Another is about the way in which for women who may be have maybe undergoing IVF treatment and embryos are being developed for the purpose of having children. And then the question about consent or decision-making with regard to making those embryos available for research afterwards with regard to the question of the commodification of stem cells and questions about international trade in stem cell lines, that may be embryonic there's questions about whether we should be painting human tissues and voting time. And so some of the questions about the use of stem cell lines for that purpose comes up but further issues with regard to regenerative medicine also concerned things like the ways in which we make our decisions about focusing on trying to revive our treatments for existing conditions, as opposed to trying to prevent conditions and different ways in which we might use resource research resources.

Sue Dods ([00:30:48](#)):

Now, each of those relates to a number of different kinds of ethical issues in different kinds of ethical frameworks that people might look to to start answering those questions. And some of those have to do with our concerns about the value of life, the value of aging, the value of, of health and the ways in which our shifts in availability of new medical technologies may change the way in which we live our lives and our attitudes towards health and our attitudes towards, you know, should I worry about my liver, if it can be regenerated? So I'll have some more beautiful south Australian wine you know, those sorts of concerns. And, and similarly, I think that, that the type one diabetes issues, those are cases where it's not so much a function of lifestyle, but other areas in diabetes type two diabetes, where should we stop worrying about eating properly and getting good exercise and avoiding obesity? If it's the case that regeneration is, is possible. I don't think we're at that stage yet, but he can see how people would see those as raising different kinds of ethics wishes.

Marianne de Macy ([00:31:48](#)):

Okay. What else back there,

Audience member ([00:31:51](#)):

How will regenerative medicine be used to treat cancer?

Dr. Keith McClain ([00:31:58](#)):

So there are a number of the number of areas, I guess, related to regenerative medicine that, that are starting to impact on, on cancer at the moment. One is the fact that we're now in a position where we're better, we're starting to develop better materials and approaches for actual diagnosis of cancer. And then also, I think, especially from an anti-technology point of view, we are starting to be able to target target materials that we can use to pinpoint where cancers are. And then you can actually potentially also deliver at the same time a drug that will, will treat that cancer. We've got much better imaging technology as well now, so that if you've actually, if you actually target cancer cells by using some marked nano material, for instance, you'd give the surgeon a better chance of actually clearing those those cancer cells.

Dr. Keith McClain ([00:32:51](#)):

So I think that the, the main area in cancer, I think at the moment is around being able to detect it and also personalize it probably in the, in the not too distant future. In terms of then you know, re replacing that, that tissue. That's certainly a possibility that will that exists at the moment, but will increase. I think, in, in using reconstructive scaffolds for instance that can deliver tissue that's being grown in the lab. I knew that people at the out of Brian in Melbourne for instance, are, are developing approaches to basically grow fat from from stem cells that can then be used as a, as an orientation for when women who cut disectomy is for instance

Max Lu ([00:33:43](#)):

I just want to add in terms of the agnostic of the early detection of cancer, nanotechnology has a lot to offer in terms of the nanoparticles tailored for detection in terms of the imaging contrast agent, as well as the added as type of imaging diagnostics, as well as the ability to deliver the payload of chemotherapy drugs, to the target regard, Jan overdosing without killing the good cells. So there's a lot of work carrying your arm. In fact, there are several drugs already on the market that used the nanoparticle as the the carrier in terms of the regeneration of the damage to cells or tissues. I think you can do a hybrid system that delivering the cells and the nutrients, along with it, to the region where you had the cancer. So while you're killing the cancer cells, it can also facilitate or enhance the growth of the good cells surrounding them. That region.

Marianne de Macy ([00:34:54](#)):

Max a little earlier, we had a concern voiced about nanotechnology and the safety of it. How can we keep track of these particles that since they're so small?

Max Lu ([00:35:03](#)):

That's, that's a very good guy and a valid consent. I think like any other new technology, you have to be concerned with the responsible use of such a technology, but people tend to associate with the hazards or the racism nanotechnology, or for that metaphor GMOs from that as technology, if you associate with just free form nanoparticles, and that's perhaps that is the, an area that we should be concerned, but most of the nanotechnology products or nanotechnology as in technology that we're resolving to products, materials that we use for regenerative medicine, for example, they are not in free form. They actually self-assembled into classes or into a certain material that scaffolds that will will contend the menopause article with say, dispersion or diffusion. So, you know, way that you have to have the nanoparticles assemble into those scaffolds, they have to be compatible.

Max Lu ([00:36:07](#)):

They had done they should not exhibit any settled toxicity. So you have to choose the materials Calfee first, and then you have to look at the effects of their size. So if they are free form, they can be done yours. You know, you have to look at the facts of those particles, whether they be persistent in the system or getting into the blood system and empathy for a long time or not, if they passed away, pass out, we didn't say the normal sort of the period, any tropical pass out, that's a little less of consent. So we have to invest in research in this area and also in the regulatory fluid build the the safeguards into those.

Marianne de Macy ([00:36:50](#)):

Okay. Anyone else want to go probably time for two more questions?

Audience member ([00:36:55](#)):

I wonder in terms of technology changing, the way we live, we all individually want to leave. We are living better and longer, and we all appreciate technology. I wonder countries are, we prepare for bodies about to come in terms of having very large populations very high percentage of people that are 90, a hundred, 120 in terms of aged care, social interaction technology is moving so quickly, but we socially or biologically, we can't adapt so quickly. What are we doing for that, that is happening or is about to happen in the next 10, 20, 30 years? That's an excellent question.

Sue Dods ([00:37:41](#)):

And I think that is the big challenge for us. I mean, one reason why we're interested in issues of regenerative medicine is so that as we live longer, we live healthier.

Sue Dods ([00:37:51](#)):

But is it the case that the reason we're living longer is because we live healthier and therefore, are we having a shift in the way in which we understand what constitutes or work life? I mean, people are now working longer. And we actually, with the shift in demography as a result of the end of the baby, boom, we need to actually continue to be parts of a society in which we are economically active, but do we need to rethink whether economic activity is all about consumption of resources within a society where we need to have questions about environmental sustainability and we'll get onto questions about food security and those sorts of issues. So how do we shift to a world in which the specific concern of an individual who might benefit from regenerative medicine? We do have a whole set of, of personal interests in being healthy and being able to restore health, but at the same time, the population effects in terms of the ways in which we actually have access to living a decent life.

Sue Dods ([00:38:49](#)):

Especially if at the moment most regenerative medicine is available in rich countries. It's not available in the majority for the majority of people. How do we address that concern of actually ensuring we're not creating a system, systematic injustice with regard to people's life expectancies and, and the kind of lives they can live. That's a really big, fantastic issue. And it is one I think we all need to be thinking about in terms of what is it to live longer for an individual, what is it for a society to see its population should happen? And how do we allocate resources within that kind of environment? Do you have personal views about how we should make that shift? I certainly think that we need to talk a lot more about the ways in which aging changes, how we understand ourselves and that we're not just biological organisms, that we need to understand that discussion in terms of who am I going to be aging with, will all of my friends be aging with me, or am I going to be the last one standing at 150?

Sue Dods ([00:39:48](#)):

I don't want to be there. Is it the case that I can have an engaged life, or am I merely going to be alive in a hothouse sort of sense? And how do we make sure that when we're doing that kind of social planning that we actually imagine what those lives will look like and do, are we going to end up splitting between the healthy age, the people who, you know, right now, or eating fantastically well, looking after themselves and what they need is sort of the support for their joints so that the body hangs out as long as they can. And those who are aging unwell how do we avoid that?

Marianne de Macy ([00:40:22](#)):

Okay. We've got time for one more question at the front there. Okay. Got one up here.

Audience member (00:40:27):

Yep. Technologies turn out always much different from what we expect 10 years ago. We weren't talking about iPads and now we have iPads. So the technology that affects the most is the least expected, most circumstances. So what would you speculate about unintended consequences of this development?

Marianne de Macy (00:40:50):

Max, you can go first on this one

Max Lu (00:40:54):

Both negative and positive as a tribute to Steve jobs. We all appreciate the gadgets that we have, and they've actually made our life much easier and not, not always better for everyone, but I think, you know, as any technology, even, even terms of technology, you have the upsides and downsides, right? So depending on how you make use of the technology. So in terms of the regenerative medicine or nano technology in general we can't predict what exactly we will end up in 10 years time. However, there are a lot of promises like this. Also a lot of issues such as the safety issues, and as long as we are conscious of those issues and work hat on addressing those issues while we develop, I think we are a more confident about the future. So I guess in terms of self to geeking the future, and we have a foresight exercise the national emerging technology strategy expert forum, my colleague was here led by around Johnson is looking into those issues, you know, the time horizon. So five years, 10 years, 20 years and 50 years. So I think foresight can better inform us on the pathways of technology and therefore, and identify issues, concerns that exactly, as you had to talk to God, the policy development thought investment guiding industry development towards the better use of technology, the positive outcomes have to add, but I think, I think it's not unexpected, but it is a dried product. Ipad is just an example.

Audience member (00:42:38):

What I'm getting at is the unintended consequences of development. That's the general motion here. I mean, do we ever get to a point where we can comfortably say [inaudible]

Max Lu (00:42:49):

Debate about nuclear energy back to, you know any of these things, but I think mankind has benefited from technology from history much, much more than the, the negative and the negative impacts that we had, you know,

Marianne de Macy / Audience member (00:43:04):

So you're saying the benefits outweigh the negatives. Yep, yep, yep, yep. Okay. Maybe one optimistic. Yeah. I have one quick question at the back. That's all we've got time for.

Audience member (00:43:13):

My name's Leslie, I'm a rural GP in the morning. I actually live with the man in the straight shirt, but I've got a few questions for the panel. I'd like to know what I'll be doing in 10 or 11 years when I'm sitting in my general practice, thinking of at the moment, the rural city divide, which is already quite dramatic, I want to know who owns these stem cells and where they're going to come from and who the patent for them and what happens 20 years down the track when the environmental influences start to act again,

do we go again or what happens once we've, we've done something and then we've got 20 years further on, we've got a bit of aging happening again.

Marianne de Macy ([00:43:48](#)):

I'd like to begin the Sue, you're talking about who owns the stem cells?

Sue Dods ([00:43:51](#)):

Sure. I mean, I certainly, we have a discussion about that. And, and it's interesting one where we've decided with regard to owning embryos that that's not something in Australia that we permit that, that the person who produces them can't own them, but the stem cell line, as you'd be aware is something which is ownable. And that's, it's arbitrary how we do that just as the urban sperm that might be used to create the embryo we treat as things which which can't be owned in the same kind of way as the pharmaceutical that may come out of the stem cell line that does make the possibility of treating these as public goods or things, which we all have an interest in, or the people who have produced them have a specific interest in becomes a real issue and ethically, as opposed to in the, within the regulatory scheme, I think that we haven't yet unpacked the significance of that, especially in things like the use of cord blood for research purposes and the suggestion in some cases of poor banking that why I'm doing preserving my cord blood is so that my child's health or my own health can be a benefit in the future.

Sue Dods ([00:45:00](#)):

But of course, if you're working in as a rural GP and someone gives birth out in a community, out in the distance, they won't have access to the capacity to have their cord blood stored, same issue happens on a global scale. And so the point I was making before about the question of the injustice that could come from focusing on the benefits to those in wealthy contexts, are those who have the access to the resources and ignoring the potential impact in terms of the broader community, I think is a really significant one. And I think the kind of question you're asking about access to healthcare in Australia outside, you know, a hundred kilometers outside of a major city is an ongoing one. And we'll get more exacerbated every time I suspect. Okay, that's a stimulating discussion, but that's all we have time for. So thank the panel for the moment. Thank you.

Marianne de Macy ([00:45:54](#)):

Let's get onto our second scenario about zero emissions cities. Again, we've got the video and then we'll get our expert panel to come up on stage.

Video audio ([00:46:03](#)):

Our buildings consume about 40% of our energy and with our emissions threatening to permanently change our climate, we need more efficient, better greener cities. We can start by being smarter with what we have passive solar buildings, public transit, private pedal, power, identity, living, and teleworking. But our food production is still a long way from most of the people who live in the cities built on the best arable land. Vertical farming could turn this on its head or at least its side. It would bring together a host of emerging technologies by putting food production on the buildings we live and working to reduce land, use coal, our oven, heat sinks and drastically reduce food. Transport costs. Modern agriculture uses 70% of the world's available, fresh water, but vertical farms could be fitted with nano films at boost condensation, and then our membranes would filter and clean recycled water, better water quality, less waste crop effectiveness will be boosted by genetic engineering to select the

best genetic variants for the environment. Fiber optics might provide light with incredible energy efficiency, one square block, farm 30 stories. High could yield much food as 10 square kilometers outdoors. There are of course, hurdles, the crops best suited to vertical farming may require us to adjust our diets, but would farmers and agribusiness take this lying down or is it simply that our dollars are best spent on smart, simple, and practical improvements to existing infrastructure and technology?

Marianne de Macy ([00:47:55](#)):

Let's see how everybody feels about this technology. Do you think that zero emissions cities would not likely change the way you live by 2020, or would you think it's likely to change the way you live by 2020? If you get your clicker pads and you can vote now you've got 10 seconds. Okay. And the results. Okay. 65 35. It's a fair split. Let's introduce our next panel. Members, professor Ian Lowe the president of the Australian conservation foundation and also professor of science technology and society at Griffith university. We can welcome back Max to the stage. And we've also heard from Dr. Dave Bowman. We'll talk about the legal and ethical inputs. Thank you. Now, Ian, you've got a comment about the video that we're just saying,

Ian Lowe ([00:48:57](#)):

Well, to give you value for money, I've actually got four comments. The first is that a food's important, but it's only a small fraction of the carbon dioxide emissions associated with urban living energy supply and use water transport, or about 90% of foods, about 10%. So while thinking about food is important, it's not the, not the big issue. It's not where I'd start in working towards zero emission cities. Second point is that it doesn't seem to me particularly rational to move people away from food producing land, into cities, and then devise high-tech ways of giving them the food that would have been available in their backyard if they'd stayed, where they lived. And the great thing about communications technology is it does offer the prospect, not just distributed energy, but distributed work, distributed productivity, distributed ideas. The only rational argument I think for spending \$43 billion on the national broadband network is to allow people to work and communicate and study where they are rather than having to move to the cities.

Ian Lowe ([00:50:03](#)):

The third point I'd make is that we should have learned by now. You can never change only one thing in a complex system. So while I applaud research being done on nanotechnology, that can clean up water and genetically modified crops, that we be more productive. We need to recognize that there are always cost as well as benefits and often unforeseen side effects. So we really need proper technology impact assessment. I think it was Barry Jan said, we now have superficial environmental assessment and no social assessment at all. But new technologies often have more serious social impacts than environmental impacts. So we really need to take the impact. Seriously. The final point I'd make is that we really should be seeing the economy as a means to an end, rather than an end in itself, that there are other things that we expect from society that are probably more important than wealth, like quality of life like security, social cohesion, and fulfillment, and the criterion for whether or not we develop a new technology. Shouldn't be whether somebody can make a motto, it should be how it contributes to those higher goals of a cohesive society in which we live a fulfilled life.

Marianne de Macy ([00:51:19](#)):

Would anyone like to ask a question or make a comment to that? Yeah. You're having trouble hearing up there. Start again with anyone who would like to ask a question. There's a question at the top there.

Yep. You could wait for the microphone. Is there someone bringing you a microphone upstairs up the front

Audience member ([00:51:51](#)):

You just gave a comment about unintended consequences of the technology, how it's more important to have a big, bigger picture of how technology is helping us rather than just narrowing down on how the targeted benefits are. My question is how much of that work is being done? Is there a specialty that, that goes into an intake, unintended consequences of the technology or the development that's going on?

Ian Lowe ([00:52:18](#)):

Jen, if other people couldn't hear it was how much work is being done on unintended consequences of new technologies. And there certainly is work done them in the academic work that Ron Johnson and people like myself have been doing for 30 or 40 years in the broad area of science technology and society is about recognizing that technologies have a wide range of social and economic and political impacts that should be studied. The general comment that can be made though, is that those who are promoting technology often have deeper pockets and a greater motivation than those who are attempting to make critical assessments of the negatives. And it's probably still true that those who are promoting new technologies have both more motivation and more resources than those who are trying to do critical assessments. So we will probably still find consequences that should have been foreseen if there was proper study that happened just because the study wasn't adequately resourced.

Marianne de Macy ([00:53:19](#)):

Max, do you have a comment about the technology?

Max Lu ([00:53:23](#)):

That kind of work in assessing the side effects or the intended consequences of technology is very important. This is exactly where common policy and regulations come in. I think that we'll have more comments on that.

Speaker ([00:53:41](#)):

Oh, regulatory frameworks are generally designed to assess human environmental health and safety at the time a product or an application is being assessed. I work in the nanotechnology area. And what I'm saying at the moment is researchers and industry who are working within that space. I actually concerned about not just the immediate impacts of that technology. There's so much scientific uncertainty within the area. They realized that there is a need to actually look beyond just what the regular theaters require. So there, the project that's about feed launched in the U S it's actually bringing NGO industry government together. And the idea is it's going to be looking at what happens when you release nanomaterials out of material. So if we talk about a nano membrane, which is one of the examples on that film, the idea is these projects will actually look at what happens when that membrane breaks down, or that film breaks down what happens to that nano material and really map the life cycle of that nanoparticle. Because at the end of the day, a company doesn't want to be liable for a huge environmental damage which they then had to clean up and pay for. So I think we're saying that there is I guess this perspective of, we need to look longer term not just short term to get through the regulatory framework. Yeah, sure.

Dr. Keith McClain ([00:54:58](#)):

If I could add something, I think it's important to give credit where credit is due. I spend a lot of my time bucketing governments for not doing enough. So when they do do something right, I think it's proper to give credit. I think it should be credited that the government has established the national technology stakeholder advisory committee that doesn't just include technocrats, but also includes people from the environmental movement, the consumer movement from socially disadvantaged groups so that there is a, at least a framework for considering these broader social impacts of new technology.

Marianne de Macy ([00:55:30](#)):

Ron, would you like to comment further on government policy in this area,

Ron Johnson ([00:55:35](#)):

Just following on Ian's comments, Ron Johnson, I'm privileged to be the chair of the expert forum with the national enabling technology strategy. And this marks almost the first time. And I think it's important that we recognize it. Perhaps a previous precedent was the concern about genetic manipulation, where governments, instead of waiting to see what happens in the marketplace and what scientists bringing up building a capability so that we start to analyze and examine potential effects in advance. So there is a modest capacity looking at where these new technologies might generate unintended consequences and how they can be designed. Precisely one major part of our program is to look at where the ways these technologies can assist people who are going, and we see are going to live longer, to live much better, living longer with a very sort of it and health-related support. So, so we, you have an expert forum that trying to be an interface. We need a great community engagement, and that's where opportunities like this are very, very important to continue to search and test these issues.

Marianne de Macy ([00:56:43](#)):

Thank you. But anyone else like to comment? We've got a question up the top there.

Audience member ([00:56:48](#)):

Hello. I have a question about the social aspect of the introduction of this kind of technology. I sort of find that a lot of, a lot of technologies when they're brought in, they're starting to distance us from our natural being, I suppose. And I suppose with this in particular, is that not taking away basically the last little connection that we actually have with the, with the earth? What, what do you guys think about this?

Ian Lowe ([00:57:23](#)):

I think that was the main point I tried to make apparently inaudibly on the top level that it doesn't seem to me to make sense to move people away from the food producing land and then develop a high-tech way to give them food. I think that we should be using modern communications technology to try and encourage people to live in the rural areas where food production is natural and where they're in touch with the earth and with natural systems. And I think they probably live more productive and more fulfilled lives. I think it's really sad that most people under the age of 30 think peas come in freezers at supermarkets and a milk comes in cartons rather than knowing where they come from. And I think that's not just a technical issue. I think we are actually more fulfilled as individuals, if we are more closely in touch with the natural systems of which we are part and probably the large scale environmental

problems stem from us being disconnected from the natural systems and not perceiving the impact of the decisions we make every day.

Speaker ([00:58:31](#)):

Sure. I think technologies advancements in technology have driven us to behave differently. You know, the social networks, you know, all these new technologies, thanks to Steve jobs have changed the gene Y social behavior. So in a similar fashion, you know, we being at using cars, individual drug, you know cars for a long, long time that's compared to our parents' generation or parents' parents' generation. I mean, that's a big social change. Now we in the context of this carbon emissions and zero emission cities, I think we need to think about the public transport. So there is I mean, I agree with we, we, as we, and, you know, the what your family is not a major part of that. I mean, although it may be a good idea, but the key part for a zero emission cities a is the integration of energy supply water, as well as you know communicate or not communicate commuting.

Speaker ([00:59:42](#)):

So they should be integrated holistically using as much as renewable energy. You can imagine cars won't be on the city streets, but you have district travelers set electrical vehicles, and people would just pop in pop out or free because powered by, by the solar and the, the thin film technology is going to be enabled, but nano technology will not only bring down the cost, but it's going to make it flexible. You can install it as a facade on the roof of any building in any given city. Then you can, in fact, this is not science fiction is a city being built in Abu Dhabi about \$22 million city, 50,000 people. They're going to use executive that sort of technology, where the water is actually recycled rainwater enable this enabled by the sort of nano membranes that we talked about. So should it be a holistically integrated system that will have minimal emissions or zero emissions? Well maybe, you know, linking to the next topic, you can actually see the side of some of the meat on top of the roof because that's where a lot of the emissions come from, because there are a lot of more CO2 generated from that lifestyle, but then, then the implants. So, but anyway, I mean, all these things should be part of the solution towards the zero issue.

Audience member ([01:01:06](#)):

There was a mentioned in the video about having to modify the plants. If we took to explore this technology, we'd need to engage in methods like genetic engineering and that's associated with a lot of controversy, how do you, how do you view that?

Speaker ([01:01:22](#)):

We here in Australia have a gene technology regulator who has been in place as one of our regulators for a number of years now. I'm sorry that we already have a regulatory framework already, that deals with GMOs. So in a respect, that's not a new issue that we would have to grapple with. I think my winter colleagues here in braids with a number of other issues that are probably more pressing than actually the dealing with GMOs. Yep. All right.

Marianne de Macy ([01:01:47](#)):

Is there anyone else that would like to make a comment question? I've a question. Sure.

Audience member ([01:01:52](#)):

Yeah. I'd like to ask whether the advent of vertical farming and also food genetic technology has to do more with the heightening cost of food rather than the scarcity of food.

Dr. Keith McClain ([01:02:06](#)):

And the answer is yes. I mean, there is no food scarcity in absolute terms. The world now produces enough food for everyone to have two kilograms of food per person per day, if it was uniformly distributed, I mean, you do the sums and divided the total food production by people. We each have on average, a kilogram of fruit and vegetables per day, half a kilogram of cereals and pulses and half a kilogram of protein. And that's more than enough for even the most dedicated trencher person. So a more rational preservation and distribution system is I would've thought a higher priority than increasing production. I mean, it's the old adage. If you can't fill the sink because the water keeps running out, you don't need a bigger tap. You need a plug. And I think the more urgent task is the social and economic. One of finding ways of better distributing the food we produce rather than increasing food production.

Max Lu ([01:03:03](#)):

Sounds like the president of the conservation says high conservation is important. Everything I agree. Totally. Yeah.

Audience member ([01:03:10](#)):

But you're also a believer that technology needs to meet other demands like increased population

Max Lu ([01:03:16](#)):

By 2050, we will have 9 billion people living on earth. I think the the food demand is probably projected to be 70% more then then when we have the use of water, problem is going to be doubled. So these are the real challenge is you know, despite the fact that we counted health food is distributed evenly. But I think in the advanced economies, we waste too much. I think that that's a, that's a problem and then caused even a bigger problem in obesity and other lifestyle diseases that I think nanotechnology also have an answer to that. So I'll talk about

Marianne de Macy ([01:03:50](#)):

It later for another session. Okay.

Dr. Keith McClain ([01:03:53](#)):

Isn't it also true that the presumption that 30% more people need 70% more food assumes that there's a continuing trend of increasing wasteful conversion of vegetable protein into animal protein. And I remember doing a back of the envelope calculation in answer to a question and a session like this. And I concluded that if the entire world were vegetarian we could reforest twice as much land as you need to soak up all the fossil carbon dioxide that we put into the air, or to put it more realistically, if we on average ate half as much meat as we do now, you could reforest enough land to soak up all the extra fossil carbon dioxide that humans put into the air. So rather than accepting that there will be an increase in the wasteful conversion of vegetable protein to animal protein. I'd like to suggest that there'll be a decrease in the wasteful conversion in the affluent societies, where there's a certain amount of epidemiological evidence that our level of meat production is actually doing us more harm than good. That is really

Marianne de Macy ([01:04:52](#)):

Hard to change human behavior. And we know that from history

Dr. Keith McClain ([01:04:58](#)):

He says that it's hard to change human behavior in the short term, but it's relatively easy to do it in the long term when I was an undergraduate, 60% of adult males smoked today, it's about 15%. Total beef consumption in Australia is about the same as it was 50 years ago, even though there's twice as many of us. So on average, we are now eating half as much beef today as we were 50 years ago. So quite significant structural changes happen over time. It's very hard to change human behavior in the short term, but in the long term human behavior does change. And we've got used to not living within walking distance, public transport and using cars not necessarily a benefit, but we've got used to it. Over 50 years, 50 years ago, it would have been unthinkable to live where you couldn't walk to a bus stop or a tram stop, or a railway station. Just a quick comment

Max Lu ([01:05:48](#)):

Coming down to the human behavior. I believe that we can change behavior if the right market mechanisms are in place. Because for example, in Brisbane, at three years ago, we had the severe drought in the, in the sanctuary the water sort of a restriction as well as combined with the rise of water costs, change people's behavior. Now we still have a by less than half of the conception. Then now we have a lot of rain. [inaudible], You know, everything else come back, we have changed the behavior. So I think energy is something that we can price correctly to change human behavior. And so we use the obesity. I mean, if it all boils down to the benefit risk sort of ratio. So if people believe okay, you, but then you eat more sugar and more calories I'm going to pay for, you know, pay the price later. I will you know, voluntarily reduce the consumption. I think it's, it's a matter of education awareness, as well as you know, understanding of those issues.

Marianne de Macy ([01:06:56](#)):

We live in a gratifying society where they want instant gratification. It's hard. Let's get the question of, well, this is all very intelligent discussion. The governments need to send a consistent message. For example, it takes me, it cost me double to take the bus to the city than to drive my little car. Our house is covered by solar panels that don't work because our council doesn't allow us to prune the trees. So I'm lost in translation. You are telling us to be conscious about, and we try to make a difference, but the government is it against us is I don't understand in

Max Lu ([01:07:41](#)):

A city of ideas. So I think I want to turn this into a CDO for good policies. Maybe you can talk through your politicians here. Yeah. But

Speaker ([01:07:50](#)):

I think you're, you're right. There does have to be a consistent message. I mean, I've said to the Queensland government, because I'm on their climate change advisory council, that it's very hard for the community to think they're serious about reducing our greenhouse gas emissions and that we should put solar panels on our roof and use public transport when they're spending squillions of public money to expand the production of coal and to be bird overseas you know, has be a consistent message. Otherwise it's very hard for people to think, well, I can make a difference when other people are what's

the it's like volunteers, planting trees with spades when on the other side of the hill bulldozers are removing them by the hectare that it's hard to feel you're making a difference is if other people are working twice as hard to move things in the opposite direction.

Audience member ([01:08:46](#)):

But you really can't because the government offers some kind of refund to have solar panels in which in most cases they can't function because they are in the shade on constantly because the councils don't allow to get rid of some branches, for example. So how is that neighborhood going to work? Yeah.

Marianne de Macy ([01:09:11](#)):

Yep. Oh, I'll take that as a comment. One more quick question.

Speaker ([01:09:14](#)):

If it were truly a comment, which I agree is, and admit is general, and that is that we as a human race seem to be fairly optimistic and not suspicious or questioning of genetic modification of the human body for medical reasons. And we're very suspicious and power white paranoid about modifying the cow or wheat or soybeans.

Marianne de Macy ([01:09:35](#)):

Does anyone want to make a comment to that? Or should we. We'll need a microphone for Sue to comment

Sue Dods ([01:09:48](#)):

And then we'll have to move on. Look, I think that in both cases we've got reasons to be concerned. It is usually the case that when we're talking about modification for the purpose of health, that we're sticking to the same species. But it is the case when it comes to genetic modification with regards to things that we're eating, people have concerns that because the motivation is primarily about profits perhaps, or about being able to use crops that don't require pesticides, that they want to ask those questions about unintended consequences, about the possibility of other aspects of the original organism coming across with the genetic genetically modified aspects. So that question about the way in which we might get diseases from species that we're not familiar with in our immune systems, don't know how to cope with and were quite appropriate concerns.

Sue Dods ([01:10:38](#)):

There's also a very large concern that many people have, which is very hard to articulate, which is an ethic that people have concerns about the ways in which you know, if we, if we start fiddling with the genes within a particular species that we actually are doing something that's unnatural or we're doing something that's, that's you know, contrary to nature. And I don't think that we actually have a way of articulating exactly what that amounts to. And I think that the concerns about the potential health, environmental, and safety issues associated with a genetic modification are, are much more ones that we can actually consider and deliberate on. And I guess that's why with regard to the the genetic modification for health, because that's so regulated and controlled, we'd have a little bit less concern about, okay, we'll have to leave it there. That's all we've got time for. So thank the panel for their wise words. We'll move on to our next scenario. Now, this is the last one. This is about synthetic meats. So once again, we'll watch a video and then we'll hear from our panel. Meat

Video audio ([01:11:45](#)):

Is an excellent source of protein and quite tasty, but at what cost, the resources required to feed 9 billion people meet Avast, even if it's just the wealthy ones. Many people are rejecting the cruelty of factory farming and practices like live animal export. And though they haven't been surveyed, it's likely the billions of primary providers, cows, sheep, pigs fish, and the rest, a debt against it could synthetic meat to be the solution. It is meat, not tofu based meat substitutes. And despite the name, not really synthetic it's actual animal cells, tissue engineers take a sample from a live adult animal. And ideally that's all they have to endure. Then they grow the adult stem cells in bats of nutrient rich broth, convert them to muscle cells because meat is muscle and grow them on a biodegradable scaffold. The only hitch is muscle cells need exercise to survive, and you can't run these ones around the paddock. You can simulate them with tiny electrical impulses, but on an industrial scale, it's prohibitively expensive research continues thus far. The biggest cat contains millions of cells and is roughly the size of a contact lens. But when synthetic meat becomes a mainstream reality where you eat lab grown steak and will knowing that no animals were harmed in the making of your burger change, the way you relate to animals,

Marianne de Macy ([01:13:22](#)):

So how does everyone feel about synthetic meat. We've got a couple of questions. So if you could get your clicker pads ready, do you think that synthetic meat technology would not likely change the way you live by 2020? Or do you think it would likely change the way you live by 2020, 10 seconds to vote option one or two? Okay. Let's see what we say. Okay. So most of you think it would not likely change the way you live this because technology won't have progressed that fast, or nobody would want to eat synthetic meat. Nobody would want to do all your old vegetarians because this not more acceptable to vegetarians. There is another question. What do you actually eat? Meat? Here's your options? No way. Never, maybe depends on how expensive or cheap it is. Give a consideration to the ethical or environmental grounds. Pass me a knife and fork. I want to eat it now. Well, you're not sure let's take a vote. So be interesting. Oh, okay. Mixed. Most of you would probably not or dependent. Yeah. It's all over the place. All right. Well, let's get our expert panel up and discuss it a bit more. Maybe you'll change your mind. First we have associate professor Wayne Pitchford, he's a beef researcher at the university of Adelaide. We can welcome back professor Max Lu who will give us insight. And then I technology and biotechnology and professor Sue Dods. Wayne, what did you think about that video?

Wayne Pitchford ([01:15:17](#)):

Well, I'll wait with livestock, so I'm quite keen on meat consumption I'm certainly not a vegetarian. There's a couple of things that strike me. The first thing is around food security and the idea of having to feed 9 billion people is a big challenge. And anything that we can do to improve protein production for that number of people is going to be a useful technology that said that food security is much more than just supplying high quality animal protein to people. It's all about an eating experience.

Marianne de Macy ([01:15:53](#)):

Smell a steak on the barbecue,

Wayne Pitchford ([01:15:55](#)):

Smell a steak on a barbecue that's, right. I mean, chicken is the cheapest major produce that we have in terms of conversion of grind to to animal protein. And yet pork is the most widely eaten meat worldwide. And in Australia chicken is the most widely meat eaten meat beef, much less. So, so food

security is much more than than, than just supplying protein. The other point I'd make is that in terms of food choice we can, we have a couple of case studies that help us actually see the value that people put on the eating experience. And that is the case study at at hungry Jackson McDonald's at the moment where people pay a premium for an Angus burger, which, you know, minces meats and the burgers are no better at hungry Jack's, but no, no, no. Th th th th at McDonald's the grand nuggets bigger is no, no better than a, than a big Mac burger in terms of the meat that's gone into that. And yet people pay a premium for the eating experience. So even if we can have a synthetic meat burger at MCAS you know, people may still pay a premium for specific eating experiences, not to say, you know, the minor changes and then a muscle with an effect. The way that we cook meat on the experience that we have in specific aging products.

Marianne de Macy ([01:17:23](#)):

Okay. Does anyone have a question for the panel

Audience member ([01:17:27](#)):

Marketing purely and simply, and, and so, and so much of what and so much of how we act socially relies on marketing. So when we talk about, and we've had a number of discussions so far about how we talk about changing behavior, but when you've got a multi billion dollar industry telling us how we should think and what we should do and how we should eat, you've got no hope challenging that in a direct and larger way. And so I think unless we start to have marketing top of mind in the things that we do, then we're not going to succeed. And I think the issue of say the successful reduction of cigarette smoking is a direct challenge to marketing the idea about which hamburger we're going to eat is a direct is a direct success of marketing. And we never talk about it in these forums and social behavior. Why do companies spend a shitload of money on marketing and a very and there's no challenge to it?

Audience member ([01:18:37](#)):

Who would like to comment on that

Sue Dods ([01:18:41](#)):

I think that you ride that one of the biggest challenges is that where there's a financial motivation then that has a very big capacity to shift the way we think we can have a society in which we're more critical about the marketing we have and about the advertising receive. And if you see some of that the idea of viral marketing and the ways in which social media are picked up is partly a response to it, but also then gets sucked up again into that same process. I think that a more critical public is one which actually asks the question, you know, and I think many people in this room, at least walking past a fast food place, know that when they say healthier lean food this is a great way of having, you know, better food that they can actually see that for what it is that they're not sucked in all the time.

Sue Dods ([01:19:29](#)):

And I think we just need to not allow ourselves to say that marketing actually controls our brains. I think that we actually know that a lot of that those financial resources can also be used in ways that we can undermine and criticize. And one of our challenges of course, is where's the, where's the space for public debate beyond the individual. And, you know, one role is for government with regard to the questions about regulation, questions about presenting alternative views. Some of it's about ways in which we can have public media sources. And you might well think that there's, you know, a whole range of issues about the way in which we present. We present messages which are buying into our

concerns about health or concerns about the environment, but don't necessarily follow through. And I, but we can create a society in which we're more critical of those things, and that then forces the marketer to, to come into a different ploy.

Wayne Pitchford ([01:20:23](#)):

Can I make a comment on that as well? You portrayed marketing as being a big bag monster, but a significant part of marketing and food product is actually a positive thing. For example, part of marketing is providing information on where the food comes from. For example, we thought, I'd tell you that all of the broccolini grind in south Australia, it doesn't just come from Woolworths, but it comes from my family farm on the fleurette peninsula. That's a good thing. If you're going to a restaurant and you look through a range of different options and you can see some of them, you know, you know, where the animals being raised, how it's been treated, what age it is that actually people are prepared to pay a premium for that that's marketing, but it's actually providing information that people want.

Marianne de Macy ([01:21:03](#)):

I'm providing people with a choice. I've got a question at the front here. Yep.

Audience member ([01:21:11](#)):

It's a general trend that when there is more money in the society, they tend to become more Non with non-vegetarian and coupled with that, how do you think that will happen? What will happen to vegetarianism? Once the synthetic meat becomes a reality, there are a lot of factors that goes into a person becoming a vegetarian, maybe ethical economic health factor, but once synthetic meat comes into it, you free up the guilt that an animal is being slaughtered for your food. How do you think that'll change vegetarianism?

Marianne de Macy ([01:21:45](#)):

Sue how do you...

Sue Dods ([01:21:48](#)):

I think there's a number of factors here. I think you're right. And you're saying there's a number of reasons why people are vegetarians and there's a number of reasons why people might continue to be, or, or stop being vegetarians in the case of synthetic meat what it does get away from is the concerns about pain during the life and suffering during the life of the animal that becomes food or about concerns about shipping of animals, between places. So we've got those sorts of concerns about animal slaughter. However, there's also questions as as Ian was saying earlier, there's the concern about the fair distribution of food and sustainability of our ways of actually providing food for people. So if I'm concerned about animals, I should also be concerned about human animals who happen to be in places where they're not currently getting access to decent food.

Sue Dods ([01:22:36](#)):

And so that we might very well say, well, perhaps synthetic meat is part of that resolution, but for the very same reasons that he gave before, if it's the case that the resources required are not sustainable to produce food in this way, or if it's the case, we've got concerns about the safety of the meat produced in this way for the reasons that we've had in, in the the regenerative medicine about the possibility of cell splitting and, and questions about mutations coming through then got reason to be concerned that this

is going to have effect on people as well. So the question of vegetarianism as someone who doesn't eat meat now, I don't think I'm going to start eating synthetic meat just because no animal is going to be to suffer at a later point, because the reasons why I'm a vegetarian don't have to do with those particular aspects about pain and suffering, or at least that's not the primary concerns, but for other people you're absolutely right.

Sue Dods ([01:23:28](#)):

The question of wealth and access to me as an indicator of wealth. It may be that that, that starts to shift. But we also have to ask the question of whether people are going to put a premium on real meat or, you know, fritters that have wandered around in fields, because it gives a better experience of eating meat that actually for many people has a bigger aesthetic value. So I think that those, that vegetarianism won't go away and some people will, for the same reason that some people refuse organ donation, some people just will not accept the idea of having a living creature, be something they can see.

Marianne de Macy ([01:24:06](#)):

Okay, just a quick comment from max, and then we'll have your question

Max Lu ([01:24:08](#)):

My comment would be on the synthetic meat. I see the fissures in that meat cause I'll well the Ford may not be in the 10 year timeframe though, but I think he will address several issues. The NMR ethics issues is one thing that explained by Susan. The second issue is the or the minimize mineralization of the food print carbon footprint, because we you've seen the size in the lab, in the bags the, the, the proteins, you know, you just need the the original stem cells. And then you have the nanotechnology modified surface that will enhance the growth of those cells by a factor of two or three. Now, now we can observe in the labs. So then means that the energy required to produce a per unit mass of the need, or the protein is going to be much, much less.

Max Lu ([01:25:08](#)):

So it's a much more energy intensive not efficient. So therefore you minimize the emissions. It can also address the taste experience. I mean, the eating experience by using nanotechnology. In fact, there are products already in Holland, in the Netherlands, there's a university called university of [inaudible] who produced this nanoparticle modified mayonnaise that actually tastes, feels like the fat sort of counterparts, but it doesn't contains the fact is that therefore give you the flavor, give you the taste, it give you everything but less the calories. So I think none of technology has a future in that. And biotechnology has a future in contributing to that football where you take longer time to produce. And also in terms of health and safety, you will be much safer. A, it will be a much healthier because you know, you can control the, the the fact ratio in a lab. But you wouldn't be able to control that unless you massage the animals. And again, the beef put it on a treadmill. So you can control all that, you know, as you can, you can imagine you can tailor design the meat for individuals, and also for different people may be some patients need different nutrients, and then you can tailor those, those kinds of meat in the lab.

Marianne de Macy ([01:26:32](#)):

That's the question at the front.

Audience member ([01:26:33](#)):

People have choices today about buying sustainable products buying fish that are more sustainable yet orange roughly is still on the market buying kangaroo over beefs. If they like their meat and therefore they can have a healthier leaner product that's naturally in this environment, but people still make choices on the cheapest type of meat. A lot of people don't buy the organic chicken, which is a happy chicken versus a non happy caged chicken. I can't find in supermarkets anymore, free range, hand products. It gets more and more difficult to find these in those markets come up, but they're not, they're not supported by the dollar and that's what drives the market. So what chance has something like synthetic meat got to enter this market, if it's all about the cost and, oh, there are a proportion of people that buy ethically and think about these things, but on a general general population, it's the dollar that drives all of this. So the technology to put into create these foods and then market these foods without the, how do you expect it to actually take off in this environment?

Marianne de Macy ([01:27:46](#)):

So Max, do you want to comment on the fact that people will in the end vote with their hip pocket?

Max Lu ([01:27:52](#)):

That's, that's correct. I mean, I'll agree in the end. I think technology not only delivers the functionality, the, the material, the, you know, the protein that you need, but also it can be part of the technology development is to reduce the cost. I think you know, when you reduce cost to the level of people can afford, then you have wild for product. I mean, like the iPhones and iPads. So I guess ultimately it would depend on, I mean, people will also choose the announcing that the national meet over the spend me for other reasons, religious reasons. I don't know. I mean, I, in many, many factors in our, in our choices,

Marianne de Macy ([01:28:40](#)):

Max, the technology is really quite interesting because it's all very well to make muscle tissue, but muscle is more complex than that. We've got blood vessels running through it. We need blood to supply nutrients and get rid of waste. How far are we off from that technology?

Max Lu ([01:28:57](#)):

Well, they are a lot of studies in the labs and trying to simulate them in muscles there the the vessels blood vessels in the in the the the cells I think it is long way to to go in terms of producing the meat is you know, meat in terms of the texture, in terms of the other features of the meat. I think that's that's exactly what the tissue engineers, all these synthetic meat sand is working on trying to develop the scuffles and putting the the the growth factors of the the nutrients that will help to grow those kinds of tissue structures. That will feel like a real meat.

Marianne de Macy ([01:29:48](#)):

It sounds an awful lot of processing for, for a burger. And one of the health messages we often get is to eat non-processed foods. I mean, how do we get around this issue? That's to comment on that?

Max Lu ([01:30:02](#)):

Well, the processing of food, I think from health was perspective the finally processed food although often tastes better, but they're not healthy have healthier. So I think in terms of the the natural ground food, where they stay awake, you know, all the the rice or, you know, meat better consumed naturally, not, you know, further processed because while processing requests energy to secondly, you know, the

processing will further enhance the chances of, for diabetes for, you know, a lot of these health problems due to the processing that actually gave you the better way of metabolizing and actually, you know enhancing the the the side effects. So if you like of those foods where men will come and say, well, it's going to paint a scenario if that's all right, it's not specifically about the processing of food, but I want you to think of a, of a scenario where you've got, you've been set a challenge to supply high quality protein, to large numbers of people that have a carbohydrate-based diet and the resources that you've been asked to design to supply this high quality protein to basically many square kilometers of desert in central Australia.

Speaker ([01:31:40](#)):

And the scenario that we have is that we've just had record rains in that region, so that there's currently more feed or grass, low quality grass in central Australia than what it's been since the mid 1970s. And so you got your little job for the nanotechnologists or for someone is to design a way to be able to convert this grass resource, which can't be eaten by humans, but convert that to something that is high quality, protein, it relatively cheap to transport and can be delivered to many people. And the answer is a cow, you know, while we've got full bellies in cities, we can have a whole lot of very targeted arguments, but if you actually think about the best way to convert vast amounts of low quality feed into high quality protein to feed people, it's very hard to do better than a cow. Can I comment to that? The answer is that a kangaroo is actually not as efficient to harvest and not as efficient at growing that high quality protein as what a cow is, rabbits breed real fast, but in the area that I'm talking about they would primarily end up as feed for dingoes. It's actually not that simple.

Audience member ([01:33:09](#)):

having been brought up on powdered egg and getting by protein from peas burrows, what's wrong with growing a bit more peas and making that more efficient.

Speaker/ Audience member ([01:33:20](#)):

I think the question was about growing more peas, these Braus high, high protein, high protein vegetables. Yeah. But this isn't food. Yeah. I don't have any problem with that, but we are a land in Australia where less than 10% of the land is arable for that sort of crop production. You know, we can in, in the U S for example, where 90% of the land is arable great corn and soybeans, and, you know, you can just drive from miles and see corn, corn, corn, but in Australia, we very little of our land is, is airable and able to go high quality crops like that. And so the ruminant species like sheep and cattle, some of our native species are specialists at being able to cope in the, in the pasture lands where you know, there's a resource that we can actually use for feeding people.

Speaker ([01:34:15](#)):

So it's not that simple. Can we grow more peace? We, we not using all of the land that we could for growing peas at the moment, but a fair bit of it just to give an example of how things are driven by the hip pocket lentils are another good example a farm manager at Roseworthy where I'm based said to me this week that he may stop growing lentils because she could currently more profitable to grow than lentils. So there are market forces in these things as well. Let's

Marianne de Macy ([01:34:49](#)):

Do a quick question on the back. Can I just ask about the crew question because again the crew crop and the Antarctic, I'm sure the Russians are just about to move in again as a very good protein source, but

you can't you can't preserve it for a long, you've got to get it to the market very quickly. We also have a problem with so many people now in official capsules and fish oils, and we're, you know, we're, we're insidiously moving into the clue crop, which of course feeds a lot of our other large mammals. Can we grow krill as a synthetic protein?

Marianne de Macy ([01:35:26](#)):

Is there anyone that would like to comment on that?

Speaker ([01:35:32](#)):

Yeah [inaudible]. Just stimulate the muscles as much and you probably don't need it to be synthetic. We just need to have an environment within which you can do that. Yeah.

Marianne de Macy ([01:35:42](#)):

Well, I think on that note, we should wrap up because we've run out of time. So thank you to our speakers and everyone on the expert panel. I think just for interest's sake, it might be a nice to see how people's opinions may have changed or stayed the same regarding these three technologies that we've explored today. So if you can get your clicker pads for the last time, we can answer these questions. So which of 'em which of the following three statements best sums up your attitude towards the developments in science and technology option one, two or three thumbs up. Okay. Let's see if we can remember what it was originally. Okay. So there's 4% of people that think that science has a negative impact on society. That's double the amount at the beginning of the session. Is that a false positive? Was that you, what was one of

Audience member ([01:36:49](#)):

The symptoms? And science is very good at finding solutions.

Max Lu ([01:37:00](#)):

Yes. To talk about not trying to feed 9 billion people with some artificial protein that maybe we should have less painful so that we don't be driven down this path. So that's why I moved to the 4%.

Marianne de Macy ([01:37:14](#)):

That's why conservation comes in. Yep. All right. Moving onto the next one, which best describes your general attitude towards the potential implications of enabling technologies like biotechnology and nanotechnology. You're more excited about it now after hearing the session, less excited, concerned, that'd be alarmed. Everyone voted or people voting. Okay. Let's see. All right. So I think it was, that's a similar result to what we had. Half the people are hopeful and the others are excited. 3% are alarmed. Who's alarmed by it. I don't think anyone's alarmed in the first one. Who's alarmed by the science. No one wants to admit it.

Marianne de Macy ([01:38:08](#)):

Okie dokie. All right. Moving onto my next one. Who should the primary decision-makers be meeting the enabling technology applications. 10 seconds to answer. Should we leave it to the scientists did note that there's no ethicists as an option ethics committees, and then an option. Let's have a look. I want as much trust in the scientist, as I thought, who doesn't trust the scientists? Yeah. Fair few of you. Okay. Anyone wanna make a comment? And that's all we have. Is that all we have? Yep. That's all good. All

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right. Well, I'm sure you'll all agree that that was a stimulating conversation. And once again, thank you to our panelists. We also want to thank us for hosting this event and also to bridge because they were the people doing the video animations that you saw. This was also supported by the national enabling technology strategy expert forum, and the department of innovation, industry science and research. So thank you to to you all for allowing the session to happen. You already.