**The G Word Transcript**

**Conversations with the CEOs of genomics: Rob Annan**

Hi, I'm Chris Wigley, CEO of Genomics England. I've spent my career at the intersection of technology, ethics and human stories. Now, I lead the amazing team here at Genomics England. We're trying to bring the benefits of genomic medicine to everyone, and that involves accelerating genomic research and also working with the NHS to bring genomics into the heart of healthcare. Genomics is a word that can trigger really strong responses, hope, fear, anger, and there's a lot of information out there. But it's not all accessible to non-experts. And there are some myths out there. So, we want to talk more about this word, The G Word: genomics. That's what this podcast is about. Welcome to The G Word.

**Chris:** It is my huge pleasure to be joined on The G Word by Rob Annan, who is the president and CEO of Genome Canada. And I should confess at this point that I was actually born in Vancouver, so Canada is a place that is dear to my heart. Rob, welcome to the pod.

**Rob:** Awesome. It's great to be here, Chris, always nice to chat with fellow Canadian. Thrilled for the conversation today, I’ve been looking forward to this.

**Chris:** Fantastic. So first of all, maybe just unpack a little bit for us, what Genome Canada does, and what you do within that context. And then maybe we can step back a little bit of understand a little bit about your personal journey. Give us the give us the Genome Canada pitch.

**Rob:** Sure. We're a national, not for profit research organisation. We're not a government agency, we exist at arm's length from the government. We were created about 20 years ago, actually, in the shadow of the Human Genome Project. So, a little history here, Canada was not actually one of the international partners in the sequencing of the human genome. And scientists in Canada who worked in those early days of genomics really made a bit a lot of noise to our federal government that we needed to make sure that we were on board with this new and emerging science. Genome Canada was actually created by the federal government in a really sort of grassroots way, led by Canadian scientists, to really provide leadership and investment in the field of genomics and to ensure that Canada will be able to both contribute to and benefit from this exciting new science. So, since then, Genome Canada has supported, in effect, large scale applied research projects. We are multispectral. So interestingly, and unlike a lot of organisations around the world, we do work in health, but we work beyond health. So while half of our portfolio is in health-related research, the other half is in agriculture, natural resources. Canada has lots of forestry, lots of fisheries, we work in energy, we work in mining. In effect, if it has DNA, we work on it. So, we really do have a broad approach. We fund large scale applied research projects that are multidisciplinary. We have a substantial sort of support for social sciences research, what we call GELs, and others refer to as LC, we call this genomics and its ethical, environmental, economic and legal implications. We really do take a broad approach to genomics, but we do work on large scale partnered research projects that are applied. We are a national organisation, so Canada has some interesting constitutional arrangements, which I'm sure we'll get into. But there are real divisions between the federal and provincial level. We work nationally through six genome centres that were operating regionally, and because of that, we have a very collaborative and coordinated approach to project development and management. About 40% of our funding actually comes from the federal government, the rest comes from other levels of government, but we also have significant investment from industry, charities, and other sources. So we really see ourselves as coordinators, as conveners, with a strategic lens on genomics for Canada, but a very broad cross sectoral approach.

**Chris:** What a fascinating breadth of role. Maybe one more question on the current role, and then we can talk about your journey. How do you know if you're doing a good job? What are the sort of indicators, the straws in the wind that say to you, yeah, this is working, you know, genomics is having an impact in Canada, or not?

**Rob:** We are all about impact. We are very much - I mentioned that we work on applied research projects – for us, it's all about implementation, and that can be implementation within the health system. But that could also be implementation in terms of new tools for either mitigating or adapting to climate change. It could be economic impact, development of weather, it’s spin off companies, intellectual property in various ways. We also really track impact when it comes to training and students, as well as the impact we have when it comes to equity and diversity. We have a variety of metrics across which we really look at the ways that we're impacting our overall mission, which is really to get genomics into the hands of those who will use it. We really see our roles as in the area of both research support, but knowledge translation mobilisation and implementation. And so for us, I would say, of course, genomics has changed a lot. In the early days, we were more about building foundations, whether it was infrastructure, or the human element, building a cohort of researchers. Today we’re much more driven by Grand Challenges, and really measuring our impact in terms of how genomics is being used.

**Chris:** Super cool. Tell us a little bit about how you wound up in this incredible kind of spider in the middle of the web type role. Do you have a deep genomics background yourself, or where have you come from?

**Rob:** Well, even as a young child, I dreamed of being President of Genome Canada. No, I’m kidding. I mean, careers only makes sense, in retrospect, right? So, in my mind, definitely has some a few twists and turns. So, I trained as a biochemist in genomics, I earned my PhD from McGill University, these were the early days of genomics. I bashed my research careers against the rocks in those early days of figuring out how to do things in a rapidly developing space. But I actually started my undergraduate work was all in the humanities, I have an undergraduate degree in literature and that was my first love and remains a major love, but I did fall in love with the science, particularly in those early days as we were starting to sequence the human genome, and so on. And so actually went back to school, ended up with a PhD in genomics, loved the science, was inspired by its use, but ended up actually on a path that took me out of the lab and into the science policy space, which is really where I've spent most of my career. So I've worked in a variety of roles in research administration, in consulting, in relations with government, think tanks, always at this intersection of research, innovation and society, and really trying to understand the ways in which we take the enterprise of science, which I think is one of the most marvellous inventions that humans have ever come up with, how we move that science forward through amazing discoveries. And then we take the benefits that come from those discoveries and we translate those into impacts on people's lives and make sure that those impacts are widely shared, that they contribute to wellbeing, whether that's social wellbeing, health wellbeing, economic well being, and so on. And so, on that interface, I've worked in a variety of roles in other organisations. And I came back to Genome Canada about five years ago, and I've been in the role of president CEO for the last three years. So, I've always been really excited by this. By, yes, the science, but it's about the impact and the application of the science and how it benefits society.

**Chris:** Very cool. If someone is sitting here as, let's say a student at University or an early career professional, I mean, firstly, I think it's hugely inspiring that you went from literature to a PhD in genomics, and maybe have a bias here, because I did computer science and medical history. So, I like other people who are also indecisive. But I guess, beyond studies, what would you say if someone wanted to break into this space? You know, as you put it, between the science, the policy, the ecosystem of actors out there, who should they send a CV to, what should they do?

**Rob:** Well, first of all, hit me up on LinkedIn. No, but really, I think it's interesting, Chris, your background as well, combining disparate kind of subjects and computer science, history, English, genomics. I think there's a real value in that. I think that in science, we do sometimes encourage and favour deep subject matter expertise at the expense of the ability to think broadly, and there's real value in that. Now, that doesn't mean that if you've pursued an undergraduate degree, and then a graduate degree, and a postdoc is one of the single area, that you can't gain that kind of experience outside of the academic system, I think it is valuable. And it is important to challenge yourself and to think broadly, because one of the things about policy is that, of course, you're balancing out any number of competing priorities and issues, and so on. And you're trying to integrate a variety of perspectives to maximise impact. And science is an important piece of that. But it's often not the only piece. So I think broad perspectives are important. I think there's a lot of skills that one wants to develop in this space. Certainly, the ability to do synthesis is important and the ability of writing and communication is certainly very important. And then in terms of how to get into this, I think there are so many opportunities now with social media and online opportunities to start, in effect, just adding your voice to conversations that exist, starting conversations you think should exist. I got into this, not to age myself, but I got into this during the heyday of blogging, the early days. And it was really just starting to comment on what I saw in this in the science policy space, as a perspective of somebody who was a New Scientist, but had a broad perspective. That allowed me to, in a sense, learn about things that were maybe little blind spots to me and build a bit of a network. So, whether it's by getting on podcasts, or starting your own podcast, or doing TikToks or whatever it is that people are doing these days, I think there's a real opportunity that way, and then to look for ways that you can apply your specialised expertise in science in a more general way. And that could be through volunteering in your community, that could be getting involved with patient groups, for instance, and in health systems, and just looking for ways that push you outside of just your scientific expertise and allows you to apply that in new ways, I think it'd be really valuable.

**Chris:** That makes a tonne of sense. Let's maybe change gear and dive into some of the work of Genome Canada. You mentioned the healthcare system in Canada, more regional or state level, than this sort of federal level. In the UK, obviously, the NHS is its own ecosystem, but the big chunk is our NHS in England and Scotland and Wales and Northern Ireland, I guess there's some level of parallel there. But how does that system work? And how do you and the team interface with that?

**Rob:** So, we'll start with a little bit of a constitutional summary. And I promise not to go too deep into this, because this gets super boring very quickly. But just to say that, in Canada, we have three layers of government, federal, provincial, municipal. Health care delivery is the responsibility of the provincial governments. So at the federal level, the federal government does not have responsibility for the majority of health care delivery, which is the responsibility of our provinces. There are exceptions to that, when it comes to health care for military, indigenous peoples, and so on. But the majority of frontline health care delivery in Canada is done at the provincial level. In Canada, we have 10 provinces and three territories. The provinces range in size from large provinces, Ontario has 10-12 million people, but we have provinces that have on the order of a few 100,000 people. So it's a huge range. And that, of course, creates challenges when it comes to scale, when it comes to new technology, when it comes to application of things like genomic medicine, for instance. The federal government does, though, have a role to play in the application of the Canada Health Act, which in a sense guarantees a national standard of service across the country and provides funding to achieve that level. It's a little messy in the sense that it's really kind of on the ground at the provincial level, but there is a federal kind of oversight, and regulatory and funding element. So we live and work in the space. We work very closely with, like I said, we have six regional genome centres that we work closely with, they are embedded within their provincial systems, they work with their provincial health care ministries, and so on, in terms of development of tools and technologies.

But in effect, we work in a couple of key areas. One general health research at a national level, which will create benefits for the provinces, because of course, we're looking at something like juvenile arthritis, or we're looking at paediatric cancer. We have large scale projects in a number of areas; those often do have, for instance, economic components that talk about, kind of implementation, costs and benefits. So we really do try to provide that to the provinces as, you know, as opportunity. We are working increasingly on implementation projects, so this is finding ways to create connections across provincial boundaries. For instance, we lead a large scale national rare disease initiative called ‘All for one’, involves the half dozen largest paediatric hospitals in the country, clinical researchers who are looking at how to actually implement genomic medicine as a standard of care. But also, importantly, all the provincial ministries are key partners in this. So, it's trying to find ways to, I guess, overcome some of the barriers that exist from a policy and constitutional perspective in order to build out these big national initiatives. And then the last thing is, increasingly, we're working on developing large scale data initiatives, much like Genomics England has been able to create this phenomenal resource for England and the National Health Service. We're looking at how we do this in Canada, which is going to require very much a federated approach, where data is going to remain in the provinces, but can then be used in a collective way to support implementation at that local and regional level. So there's a lot of work to be done there. COVID provided us a huge opportunity to push through some of those barriers, some of which were more significant than others. But there's still a long way to go.

**Chris:** That's pretty complex. I can appreciate the number of moving parts in that system. And within an initiative like, sorry, was it ‘All for one’, the Rare Disease Initiative? Conscious of the complexities around things like data staying in its own area, what kind of role do Genome Canada play in bringing those actors together, or who does what, in an initiative like that?

**Rob:** Our role is really, in a sense, to bring together as a convener and a coordinator, the key decision makers, the key problem solvers, the key technical people, and so on. So we have a variety of groups that are supported through that initiative, for instance, that are working on issues around data governance, around consent. In some ways, the technical issues are kind of the most straightforward ones to solve. I mean, someone has to convene the meetings where we actually get together. But we worked very closely, we tried to adhere to global standards – the Global Alliance for Genomics and Health, for instance, which is based out of Toronto, helps to provide, I think, a general framework on the technical side. It also helps to support the conversations we're having when it comes to some of these kinds of thornier questions. But we don't have at Genome Canada, the mandate or the authority, to, in a sense, impose these kinds of, look, this is how we're going to do it, this is what consent is going to look like, this is how we're going to handle governance. Rather, we actually sort of create the tables at which those different actors can come together and find mechanisms to do that work.

**Chris:** Got it. And in terms of the kind of outcomes that you're trying to enable in areas like cancer, rare diseases, and so on, how do you think about the kinds of industrial partnerships that you as Genome Canada have, and then I guess, you interface with the healthcare system? There's that kind of old cliche about Europe is great at turning money into science, and America is great at turning science into money. Where does Canada sit on that spectrum? And how do you handle concerns or anxieties around, you know, is Genome Canada just taking my most sensitive data in my DNA and selling it to companies? How do you set things up so that the relevant folks are all kind of on board and feeling good about shaping these things?

**Rob:** That's a really great question. Something that we think about a lot at Genome Canada, and maybe in a stereotypically Canadian way, we kind of live a little bit in between, kind of in the middle between the European and American tendencies when it comes to money and science. So, Canada, generally, it varies a little bit from province to province. So, you'll want us to keep that in mind when we think about your kind of health data. But we tend to be a very conservative jurisdiction, when it comes to the sharing of data and making data available. And that is particularly true when it comes to making it available to industrial partners, to pharmaceutical companies, and so on. So, there are certainly initiatives, largely at the pilot level, to build new partnerships here. I will say that one area where Canada really excels is in launching pilot initiatives. So maybe that's our niche, when it comes to sciences, we’re the great pilot initiative country. But we do have a number of pilot level initiatives working with companies.

But I would say that, when it comes to health data, we tend to keep things very much even at the local level. So, rolling that up into a point where we can actually make that available for large scale access for companies is something that is not where we're at now. And frankly, it's a bit of a culture, it will be a cultural shift to make that available. But ironically, and this is something that we that we talk about a lot when it comes to regulatory environment, and so on. While there is a real concern around privacy, Canadians, by the thousands, are sending their DNA to 23andme or ancestry.com. Or what have you, right? And then we also have communities of, for instance, rare disease patients and their families, self-organising on Facebook, and so on. So this isn't just unique to Canada, this is true in other jurisdictions, too. But having the regulatory environment keep pace with the needs and wants of the communities, as well as the opportunities that exist on the commercial side is an ongoing challenge here. So that's something we're navigating.

I think, when it comes to just data sharing more broadly, we have a long history of struggling with this in Canada. When it comes to health data, a little anecdote from the side here, when I first went COVID, for instance, you know, my background is not from the medical side, I come from kind of a fundamental basic sciences. And so I got pulled into a variety of different tables, really looking at linking up hospitals and sharing genomic data at scale so that we can start to viral surveillance, for instance, or large-scale human cohorts that we were contemplating. And you know, I remember hearing in a few meetings talking about facts- based medicine and the challenges this was going to pose during the pandemic. And I was thinking, well, if there's ever a time you need evidence, it's during a pandemic. Until it was clarified that by facts based, they didn't mean evidence, they meant fax machine-based systems. In many ways, when it came to sharing data between hospitals, that there were some systems that were still relying on found empty technology, I'd been very clear that we were not going to be sharing any genomic data by fax machine.

**Chris:** Sorry to interrupt you, I just have to share this brief anecdote. I will not mention the country in question. But I was talking to someone who was playing an advisory role to a country that was setting up a national genomics programme. And this is in a very highly advanced, technically leading country. And they said, right, well, at the moment, all of the genomic data sits in the hospitals, and you're talking about wanting to try and create a national layer of this for research purposes, and so on, the kind of things we've been discussing, how can we get it to the National Research Centre? And someone in the meeting did suggest faxing it, without irony. Other people would say, well, 3.2 billion letters, or you know, base pairs, kind of translates into quite a lot of fax paper, we might want to think about another means.

**Rob:** No kidding. But that's the one hand, you know. So, the one hand is that there's certainly, I think, systemic issues in Canada. I don't want to ignore them, but they were proving too challenging during non-pandemic times to sort of overcome. We've come a long way during COVID to addressing these, I would say, more systemic issues, more policy issues, and so on, which is important because the other hand is that we have researchers and we have hospitals that really are world class. I think about our large scale sequencing centres in Toronto and Montreal and Vancouver, are absolutely, you know, top notch. The worst thing was on Sick Kids Hospital, or CHEO here in my own province of Ontario, another Children's Hospital, they are plugged in to the global ecosystem when it comes to Rare Diseases Research, are leaders in many ways. So, we really do have phenomenal activity happening. It's just not linking up, right? So we are getting world class standard of care in hospitals, we are getting a phenomenal, you know, kind of advances happening at the individual researcher and clinician level. But we have, unfortunately, for a number of systemic issues, just challenges in linking that up into the large scale data sharing that's going to be required to really do the kind of innovation necessary, whether it's on the diagnostics or therapeutics side going forward.

**Chris:** This may sound like a sort of very basic question. But why does that matter? Why does it matter to join up? What are the benefits that you see from increasing that joined up-nesss compared to just having a bunch of Centres of Excellence?

**Rob:** Well, I think it's not either or, it's a little bit of both. And I think we've got – the centres of excellence exist, and that's important and valuable. I just think that we are going to be leaving opportunity on the table, if we don't leverage the strengths from the regions into something that will, in the end, where they say the whole is greater than the sum of its parts, right? If we can link up the datasets that are being created at provincial levels into something national whereby, you know, hospitals in smaller regions or smaller provinces are able to access large scale datasets for improved diagnostics, for instance, that's a huge benefit. That's a huge benefit, right? Ontario, maybe Quebec could conceivably go it alone with large scale data if they really maximise their potential, but some of our smaller provinces that have only got three- or four- hundred thousand people will never have the datasets large enough to really sustain the kind of diagnostic needs as well, never mind the innovation side of things. So I think that there's real opportunity that we'll miss, never mind what we can build off of that when it comes to, for instance, clinical trials and opportunities here. Canada is a bit of a unique place, just from a population perspective. We are a reasonably small population, spread out geographically of course, but because of the history of immigration, we have a very diverse population. There are real advantages there for things like clinical trials, for instance. So taking advantage of that, but there's more that can be done there.

The last thing I'll say is, when it comes to data and data sharing, another area that we spend some time on Genome Canada, and others and within our ecosystem spend a lot of time on, is thinking about data sharing and data governance when it comes to indigenous peoples in Canada. And there is a long and justifiable history of mistrust between the medical establishment and indigenous peoples in Canada and around the world. That people on both sides are working hard to repair, to move past. We support a phenomenal project called *Silent Genomes*, which is led by indigenous researchers out of Northern British Columbia, really looking to build a biobank of indigenous biological samples. But they're also focused a lot on these questions of access and governance around data. And thinking about this from a very different perspective, that is informing the work we're doing in our other projects. So, we have a variety of different kind of approaches and initiatives that are going on when it comes to data and data sharing in the health space. And some of those are unique to our situation in Canada, but will no doubt have implications for others.

**Chris:** Yeah, I was talking to Andrea Ramirez, who's the CIO at *All of Us*, the large US-based genomics and healthcare research programme. And suddenly, a lot of common themes there, in terms of the work that programme is doing, and that indigenous tribal leaders in the US are doing to kind of build those bridges as well, feels like a very strong theme. Maybe a final question on healthcare and then we can move on to some of the other areas where you guys are still active? Where would you like to be in, let's say, 10 years’ time with genomics in health care in Canada?

**Rob:** Yeah, I mean, like everywhere, I would just love to see greater application of genomics in the clinic, in areas where we know we can have a big impact. That includes rare disease, certainly, but also in cancer. There's a variety of other areas, of course, that we're going to have a big impact. In Canada, I think the big areas, and this is where we're focusing our energy right now, are on developing sort of scalable approaches around Federation of data, so that healthcare providers will have access to the data that they need, wherever they are in the country. And so we're thinking here about equitable access, that will be a challenge, but one that we think we have a path on, from a policy perspective, a technical perspective, and, frankly, a bit of a culture and practice perspective. So that's one big area.

The other area that I think is that isn't a focus for us, and that will be key, is applying a bit of an equity lens to that data. So, certainly, working with indigenous peoples here, and those that are leading initiatives in our space, will be really important to ensure that we're building a system that is relevant for the indigenous people in Canada. But also thinking about underrepresented communities, whether those are communities that live in urban environments in Canada, or rural environments in Canada. Equitable access to health care is a problem everywhere, and you can well imagine in a country like Canada, access in the north, for instance, is very distinct from what you would get in, in downtown in our major cities. So, thinking about equitable access, but also equitable representation within datasets is a major focus for us.

And then we have a lot of work to do on, I guess, sort of the social and implementation side. So how do we make sure that the healthcare systems – now here we're talking about physicians and nurses, and counsellors, and so on – are working with this kind of information in a way that's very patient centric, that patients feel empowered by the information they're getting, and that patients are able to have control over what happens with their healthcare, based on the kind of information that genomics can provide? So, that's not really a technical challenge, right? Those are more systems and social challenges, but are ones that we can't ignore – I have to admit, it’s very easy to get distracted by the unbelievable scientific and technical progress we've made in the space and I'm dazzled on a day to day basis at what we can do, I really do feel like I'm living in kind of a sci fi future sometimes. But we can't ignore the social side of how that science gets applied. And that's both in terms of equity, but also in terms of the systems that we need to make sure that it maximises impact.

**Chris:** Absolutely. And that's a really delicate balance, right? As you say, so much of that is about empowering the people whose data it is to be involved in making those decisions, not just be passive recipients of what some self-nominated group of greater good or whatever decided is best.

It's interesting, actually, it's quite an interesting segue there, I guess, between genomics in healthcare context and genomics in other contexts. We had as a guest on the podcast a little while ago, Sir Patrick Vallance, who's the government's chief scientific adviser. The Government Office of Science published a deliberately provocative piece called *genomics beyond healthcare*, to try and spur other government departments to think about how this technology was coming down the road and what it might mean for them. And there was some very clearly and clearly labelled kind of speculation in there, in question for, you know, could genomics inform sentencing? Could genomics inform education pathways? Could genomics inform all sorts of other things? And we've certainly had a few anxious patients and participants call us up and saying, hold on a second, are we like the lab rats to kind of create Gattaca, like what's going on? To which, of course, the answer is no, you know, the way that that data was collected and stored is very explicitly for medical research only.

And you mentioned a bunch of other areas that I'd love to get into, like agriculture, forestry, fisheries, and climate change, and so on. I guess maybe a tiny bit nearer in, do you also have any sort of thinking on other kind of social sciences areas or other areas of government where genomics could be relevant, or have guys kind of parked those kinds of questions to one side?

**Rob:** Well, certainly, we support a variety of projects that really are looking at some of the ethical and social issues around genomics and how those would impact on some of the areas you talked about. Genome Canada, we ourselves don't have any specific activities in justice, for instance. When it comes to human genomics, we are really focused on the health side of things, outside of kind of the philosophy and ethics and so on, where we do support a fair bit of work in that space. When we think about getting outside of health, it's actually getting outside of humans, I should say, and it's really thinking then about plants and animals and microbes. And there, we do a lot of work with, on the government department side, of course, natural resources and agriculture and fisheries, and all of those spaces. A lot of work in climate. And I can talk a little bit about the work that we're doing on, for instance, biodiversity and surveillance. Canada is a big country, the geographical scope of Canada is immense, we have a lot of ocean, we have a lot of forest, we have a lot of lakes, and we don't have a tonne of people out there just paying attention to the on the ground kind of biodiversity monitoring. It's just impossible to do large scale surveillance without more advanced tools. So, we've been working hard to develop tools around e-DNA, for instance, environmental DNA. So, this is the ability to actually use the DNA that's shared within a water column, for instance, to then be able to, in effect, identify populations of species, not just species composition, but population, and attract that composition over time. We work with our partners in Quebec – Genome Quebec, they have a project actually working with schools that are out there doing water sampling in their own little local region and sending samples in so that they can contribute to provincial water system monitoring, through e-DNA projects, for instance. So we do work like that.

**Chris:** It’s almost like, in the pandemic, there was a lot of both talk about and practice of things like pathogen genomics surveillance, through sewage in cities, and so on, right, to get a sense of levels of infection. This is kind of like the outdoors nature version of pathogens surveillance, right?

**Chris:** Yeah, absolutely. That's exactly right. It's doing the same kind of surveillance. And we can do this, I mean, looking for viral DNA in wastewater is phenomenal. But we can look for other types of DNA, you know, we’re actually evolving a lot of the surveillance systems that we had helped develop during COVID. Start looking for markers of antimicrobial resistance, for instance, in wastewater, and in environmental systems. So, helping support this kind of technology development is a big piece of what we do. We work in another area around sea biodiversity, is we work with a variety of indigenous communities in the north, for instance, looking at caribou populations. So food security, in Canada, you know, I remember years ago learning that when you live in the north, food has fur, right? You don't live in the Arctic and, you know, grow lentils and corn, and so on. So caribou populations matter when it comes to food security. And those populations have been falling precipitously. So we've been working with communities to, again, look at ways to use environmental DNA, a DNA that is found in scat, for instance, to be able to track populations. And then we're combining that with traditional knowledge from indigenous communities, to be able to actually create a bit of a more holistic picture of how those populations are changing over time, and informing what we can do around conservation. So we have projects like that on climate, we also do a lot of work in agriculture. You know, whether it's on improving productivity, of course, agriculture is a major export for Canada, a huge economic sector. So looking at different ways to improve yield and productivity, but also adapt to a changing climate, to introduce different traits when it comes to drip resistance and heat tolerance, and so on. So we've been supporting the sequencing of a variety of wild relatives to our major crops like wheat and canola and lentils, and so on. But also looking at mitigation when it comes to livestock. So we have a variety of projects in those areas.

And then we have some projects you might not expect. We do a lot of work in the energy sector, for instance. So energy is a major export as well for Canada. We work on with large scale energy producers, for instance, when it comes to risks around oil spills, or cleanup of tailing ponds. The development of microbial communities that can contribute to helping to degrade the products, by-products, whether that's of oil spills, or whether it's from the actual production. But also, when it comes to things like exploration. We have a really phenomenal research project that has identified bacteria that feed off hydrocarbons. And so this project is actually looking at ways to identify these hydrocarbon bacteria in sediment as a way to enrich for possible drilling deposits, for instance. So there are different tools and technologies, and we're finding ways to leverage, you know, the great investments we've made in a lot of our technologies and platforms, leveraging that insight of health to actually support interesting innovation in other sectors.

**Chris:** Incredible. And I remember when the AlphaFold algorithm came out and was suddenly accurately predicting protein structures, and being able to use that to design new proteins, and so on. One of the big use cases that people were excited about were things like designing proteins that could decompose plastic bags in the ocean. Are you an optimist for how genomics proteins can play a role in these areas around, as you mentioned, environmental degradation, and so on?

**Rob:** I am sort of whatever, by veil and here, right? I'm both optimistic and pessimistic. Like, I have to say that I'm a huge optimist when it comes to the scientific potential. I just, I honestly, it's like week to week, my mind is blown when I see the projects that come in and what we are looking at, what we can do. We have an open project, an open call right now, to look at new initiatives to mitigate the impact of climate change in our agriculture and food systems. And the stuff that's coming in is unreal. It's so creative, so phenomenal, using amazing technologies. We're doing a lot of work, we plan to launch something on the circular bio economy – again, really foreign innovative thinking when it comes to thinking with sustainable manufacturing, for instance. So I have enormous faith in our ability to develop technologies and knowledge that are going to provide us huge opportunities.

The flip side to that, of course, is I struggle sometimes to keep the same level of faith in our social systems. And, certainly, we lived with this during COVID, when we developed in almost miraculous time, these mRNA-based vaccines. We were able to use genomic data from the virus, but all sorts of other bio manufacturing technologies to create an unbelievable response. But then we saw the social reality of systems that struggled to deploy and to accept these technologies. So, I think that we ignore that at our peril. I really do think that we have to invest the same kind of time and energy into thinking about how we ensure that people see the opportunity for their own benefit in these technologies, that we ensure that those benefits are shared equitably, across not just our own societies, but globally. And that we take seriously some of the risks of, you know, whether it's hubris on the scientific side, or of pushback on the public side, we take those seriously, because that will be what undermines the potential that I'm so optimistic about.

**Chris:** Well, I don't think we could get a better manifesto for the future there. Equity of access, improvements in human health, improvements in the environment, improvements in our ability as a society to translate those scientific breakthroughs into meaningful, scaled improvements in people's lives. That's what I'm going to hang on to from this conversation. Super impressive. Rob, thank you so much for taking the time to share some of your experiences and hopes and dreams with us. And I look forward to living in that brighter version of the future.

**Rob:** Awesome. Well, thanks, Chris. And a big shout out to you guys at Genomics England for all the work you're doing, and all the work you've done. It's been great working with you and the rest of the game there. Thanks for the invitation, I really enjoyed this today.

**Chris:** Well, that's all for this episode. Thanks for listening to this discussion about The G Word and for joining us on this journey to highlight and debate the implications of genomics as it comes to the mainstream of healthcare and society. Remember to subscribe to The G Word on Apple podcasts, Spotify, or wherever you listen. If you have views on these topics, or if you have a suggestion for someone we should interview, then do write to us at podcast@genomicsengland.co.uk. And do remember, if you've enjoyed listening, that giving us a five star review really helps other people find out about the series that appreciate it very much. See you on the next episode of The G Word.