AT: Welcome to the Infinite Woman podcast. I'm your host, Allison Tyra. And today I'm joined by CSIRO's Dr. Denis Bauer, whose work focuses on improving human health by applying cloud-computing technology to better understanding the genome. We'll dig into that research a bit later, but first we're going to chat about one of Dr. Bauer's scientific forebears - Rosalind Franklin. Let's start with, what is the significance of Rosalind Franklin to the field of genetics?

DB: Rosalind was the first to actually use X-ray diffraction images in order to look at DNA crystals, and she did that at the King's College in London. And this really was improving the techniques that were there already before, but this time to get a clearer image of the actual DNA. Therefore, out of this came the infamous photo 51, which her student Raymond Gosling was taking. And it really showed how the crystal actually looks like. And from there, they could deduct that it must be a helical structure, which is the famous double helix that we all know the DNA looks today. And this was really done at the same time, as Watson and Crick.

AT: And for anyone who's not aware, Francis Crick, James Watson, and Franklin's colleague shared the Nobel Prize in Physiology or Medicine in 1962, for essentially what we're talking about, identifying the structure of DNA. But it seems like all her colleague actually did was just give the image that her student took using her techniques to Crick and Watson. So I would question why he was getting the Nobel.

DB: Yeah, the way that I think research in general works is that you come together, and you talk about things, and then ultimately, sort of the effort of multiple people. And it's really hard to identify whose contribution was exactly what and how it has led to certain discovery. So my understanding of how things were back then, is that Rosalind, and her student, Raymond, they got this image, and they hunkered down to actually calculate the exact structure from from that image. And that took them quite some time. And at the same time, Crick and Watson and Franklin's colleague, Wilkins, were working on a rough approximation of it. And therefore, when they saw that image, it sort of sparked that epiphany, probably in their mind that, hey, it could be a double helix. And therefore it was published, their work was published back to back. Watson and Crick were in the journal as well as Rosalind's pure, beautiful calculations were in the journal. And then I think why she didn't get the Nobel Prize, was really boiling down to that she unfortunately died before it was awarded in 1962. So she died 1958 at 37 And therefore, the Nobel Prize is not awarded posthumously. So therefore, we can only speculate whether at the time, she would have gotten it or not.

AT: And it's interesting to note that when she died, she was only 37. But she was leading pioneering work on the molecular structure of viruses. And her teammate Aaron Klug continued her work, and he then won the Nobel Prize in Chemistry in 1982. It's crazy to me that she was part of Nobel Prize-winning work twice in two different fields before the age of 40. That's nuts.

DB: Absolutely, I mean, this really attests to her brilliance, right, that she can think so fundamentally, and done fundamentally improving work, in two different fields, and she probably would have right and moved on to have even more insights and more contributions to science, if she did not die so early. So yeah, it really attests to her brilliance.

AT: And when I read her story, because she is sort of held up as, you know, this classic person who made a major contribution and was then overlooked, and even if we acknowledge that, she was technically ineligible for that Nobel, it still seems funny to me that they included Maurice Wilkins, her colleague, not least because he did not like her. From everything I've read, they just she was a very assertive woman. And naturally, that tends to make us unlikable, depending on the people you're around, and I've seen her described as like brusque and forceful. And so I don't know how much of this is just, you know, the misogyny of the 1950s. And I find it interesting because, she was dealing with men like Watson who racked up decades of racist, sexist, homophobic, anti-semitic, even fat-shaming remarks. He made offensive comments about Franklin herself. But

even then, I read that Watson originally wanted to talk to Franklin herself, rather than Wilkins. But he'd pissed her off by implying that she didn't know how to interpret her own data. And even Crick later acknowledged, “I'm afraid we always use to adopt, let's say, a patronizing attitude towards her.” So you do have to wonder how much of this, “brusque” personality that she was known for was just having to put up with this nonsense all the time.

DB: Yes, yes, absolutely. I think, you know, in science, in general, you have to get to have a thick skin in order to succeed, because whether you're male or female, your theories are always scrutinized. So therefore, it's not for the faint-hearted. But it must have been even harder at that, at that time of, in the 1950s, as you said, where in general, it was quite unusual for a female to be in research, let alone make world-changing discoveries.

AT: I found it interesting when I was looking at Rosalind Franklin's earlier life, she came of age during World War II. So she was born in 1920, to a British Jewish family. And in her adolescence, her parents helped Jewish refugees fleeing the Nazis, including housing two Jewish children. And then later, in her final year at Cambridge, she became close friends with Adrienne Weill, a French refugee, who'd been a student of Marie Curie’s. Wiell helped bring set Franklin on her path to crystallography and the job at King's College, she patrolled as an air raid warden in Cambridge. You do have to wonder how much of that would have shaped her as a child and a young adult. And then, to enter the professional world with certain characteristics that have been impacted by those early experiences.

DB: Absolutely. So I remember in Double Helix or one of those other publications that Watson made, he was saying that if only she collaborated more, it would have been easier for her to be accepted better. And I think this comes down to the experience in her life. So she had to be self-reliant, she had to do things herself, like patrolling as air raid warden. I mean, that is quite something that you have to have a stomach for, to actually do that. And this, to me, really speaks to her strong willingness and her self-reliance for doing things and discovering things herself.

AT: And I will say, as someone who's studied a lot of women's history, a lot of times when women collaborate, they just magically don't get any credit for their work, especially in the sciences. So I would imagine as a woman in that environment, she was likely aware that that would have been a risk. And she also just may not have wanted to, which is perfectly valid. But yeah, I would be a little leery of collaborating in that environment, if I was a woman surrounded by men and seeing what happens to other women scientists.

DB: And even nowadays, people tend to not collaborate for whatever reason that they have around retaining the IP or wanting to make it themselves or wanting to have the breakthrough epiphany themselves. There are various reasons to not collaborate. So therefore, trying to fit people into that mold, that you have to act like everybody else, is just not right.

AT: And so if we want to fast forward several decades. You are doing work that I freely admit, I do not understand. But it seems like you're harnessing computing technology to speed up research that helps scientists better understand and fight diseases, including analyzing the COVID-19 genome to help develop vaccines and molecular contact tracing. So could you tell me a little bit more about your work and how it works and what it means?

DB: Yeah. So just like Rosalind was looking at the DNA through X-rays, we are looking at the DNA through the help of computers. So we're using supercomputers and distributed computers, in order to make sense of the data. So we don't have to look at an image and calculate it by hand, or it could mean what the structure is. We're using computers in order to make sense of the numbers that we're seeing from the data is specifically

around finding disease genes, for example. So not falling into the same trap as, as Watson trying to explain everything with genomics. But there are clear risk factors, obviously, encoded in your genome, that's making an increase in, say, suffering from a heart attack or any other cardiovascular incident. And being able to detect that before symptoms appear, I think is going to be crucial to really have the preventative mechanisms of measures beforehand, before you actually have symptoms. And so this is our human genomics field. And we're, as you alluded to, we're also working on COVID-19 genomes. So the virus genome, and I think, relating, again to Rosalind, is that, as a scientist, you like to contribute to many different areas, with your expertise. And for the COVID work, we're sort of approaching it, basically, with a similar question, can we predict something from the virus genome that is influencing the disease outcome? So specifically, are there any mutations in the virus of the genome that could make a severe disease outcome or a mild disease outcome? And again, we're using computers and machine learning in order to predict exactly that. And we did find a lot of mutations in the virus, not only in the spike protein, which is where the current the vaccine is assigned for, which is the most well-known structure, molecule in the virus, but in other areas as well. And one of those are shown to actually modulate the host immune response. And you can see how this could lead to a mild or severe outcome.

AT: And you actually won the CSIRO Collaboration Medal for that. And it seems like, going back to this issue of collaborating, I understand that you developed an open source, AI-based cloud service that accelerates disease research. So I'm intrigued by the open source aspect, because it does seem like scientists are a lot more productive and get things done faster, when they're sharing information freely. And I think that's part of why we were able to get vaccines for COVID so quickly, because there was a lot of sharing. So the open source aspect, is the idea there, if we all share, then we'll all do better?

DB: Exactly, yes. Because multiple brains together come up with more things than the sum of their parts. But I think we are quite fortunate that nowadays, when we share things,there's a record of that, right? So it's, it's not that you show the picture to a person and that person runs off and gets credit. There is a record of you having shown that picture, and therefore you can prove that what your contribution is. I feel like hogging the results is less empirical. Nowadays, you do get the credit, and you can share the information openly. And we can build off of each other's ideas in a much more collegial, I would assume, environment rather than what they were doing in 1950s.

AT: And there's also a lot more, I would say, venues to share information with. You don't have to, you know, send someone a letter and wait, possibly weeks to get a response. It's just oh, I'll just send that person an email. And like you said, there's a record and everything. So it's not, I think the accessibility of sharing information is so much bigger now than it would have been 50 years ago.

DB: Yeah, absolutely. So I think 50 years ago, there were three or four journals that you wanted to publish in. And therefore, it was very hard to get into those. Whereas nowadays, there's so many more scientific peer-reviewed journals that are of high quality where you can get your work seen, peer-reviewed, get the feedback from others. So it's a much faster cycle I think that we have. Of course, this comes with a downside of misinformation. And therefore, as a scientist, nowadays, I think it's fantastic to collaborate. But you also need to know who to trust and how to collaborate with those people. So maybe there is an element after all of you need to find the right people surrounding you, in order to make impact.

AT: What's that saying about, “A lie will make it around the world multiple times before the truth finishes putting on its shoes.” Once misinformation goes out there, even if the person who put it out there in the first place, realizes that they were wrong, and tries to refute it. Like I think probably the most famous instance is the refuted study that vaccines cause autism, which, of course, is not true. The author of that original study himself has repeatedly denounced those findings. And yet, it persists. So it seems like fighting misinformation is just so difficult once it's out there.

DB: Absolutely. The most persuasive arguments sometimes is sticking in your in your head. So this makes me think of why, because both both studies were published at the same time, Watson and Crick, as well as Rosalind Franklin. Whereas back then, as well, one was more hyped, compared to to the other. And one element to that, surely might be that she was a woman. But I'm wondering how much of the way that things are communicated is another element to it, the marketing of it, if you will. And someone who's really trying to get the beautiful math problem solved and demonstrate it through that. Whereas, in contrast, people that have the story, right. That's sort of the two elements to it as well. And I think that's to this day, that's exactly the problem sometimes that you have to have, that you need to not only be right, but you also need to sell it the right way, in order to get the impact.

AT: People respond to pizzazz, not necessarily someone providing them with an informational lecture.

DB: That's right.

AT: And interestingly, the same thing happened to Nettie Stevens, decades earlier when she and a man both published their findings about the sex chromosomes at the same time, and her work was actually more accurate. Like it over time, it was shown that her findings were more accurate. And the guy didn't even study eggs. He said they were too fatty for his microscope slides. So he just only looked at sperm. And yeah, he later, like noted her when he published future papers. But he's out there getting sole credit when they published at the exact same time. And she's not even allowed to attend meetings where her own findings are being studied.

DB: Yes. Isn't it interesting how it's so multifaceted. One is gender. The other one is marketing. And the third one is probably being at the right time at the right place.

AT: So looking at genetics today, I would say CRISPR was probably like, at least from the mainstream perspective, it was probably the biggest genetics news of recent years. For people who weren't in the field for us to actually have heard about something has to be pretty big news, I would say. And so do you want to tell us about Emmanuelle Charpentier and Jennifer Doudna?

DB: Yeah, exactly. So CRISPR exists in nature as the immune system of the bacteria, right? So it's for the bacteria to fight stuff that is entering their cells. But Emmanuelle Charpentier and Jennifer Doudna were studying this and they had the epiphany that you could use that mechanism in order to edit cells. And with that, of course, there's this whole new world of now editing the genome. So not only understanding it, what we've been doing for decades, now we are in the position of making actually changes to the genome to reduce disease risks, for example, or potentially eradicate genetic diseases all together. And of course, then in the biotechnology space as well to edit certain cells to, for example, detect pathogens in a biosensor kind of way, rather than through mechanical detection. So, with that CRISPR is really, I think, they were saying the discovery of this century. When you think of that there's computers, there are other things that really have changed the way that I think our world works, but CRISPR really has the potential to taking that up a notch. And therefore there was obviously this contested area, you actually did the invention, you should receive the patent for it. Because when you think about it, that's a multi-billion, trillion dollar kind of entity. And, therefore, the Broad Institute and Berkeley were in that contested lawsuit around who is actually owning the patent. It got settled, with the Nobel Prize following shortly after that, of awarding that innovation, of the detection of that to Emmanuelle Charpentier and Jennifer Doudna, which of course, wasn't an easy path. So there was a lot of marketing, and trying to sell the right thing at the right time, elements to that as well, where the Broad Institute were trying to publish an article saying these are the heroes of CRISPR. And they left strategically Emanuelel and Jennifer out of that, because likely, of the lawsuit that is raging underneath all of this. And so it comes back

to that nothing is really black and white, everything has so many layers to it. And gender being one of them. Being in a fortunate position we're in nowadays, even in that scenario, there are winners and losers.

AT: And I think it's also a question of, from a marketing standpoint, the flash of brilliance, story is very appealing, like we love this idea of just, a genius having an epiphany, but it does seem like most science is not that. It's a lot of hard work and processes and trying things and that didn't work, so we tried something else.

DB: Absolutely. So from our perspective, it's so hard we need to attribute a certain discovery to a certain person or group of persons. Because it's hard to really to determine when was it discovered, what was just before that discovery? What has happened there, who has said what that sparked an idea and so on. So yeah, science is incredibly messy, but we like to tell stories, and it's easier if stories have heroes, and therefore we always coming back to those individual heroes just for the sake of the story.

AT: Join us next time on the Infinite Women podcast and remember, well-behaved women rarely make history