Transcript: Plant Breeding Stories Podcast
S3E8 - Dr Greg Baute, Aurora Cannabis

[Theme music plays]

Hannah Senior: Welcome to this episode of The Plant Breeding Stories podcast, where I talk to leading lights in plant breeding, asking what they do, what makes them tick and what fascinates them about the world of plants. I'm your host, Hannah Senior, of PBS International, world leaders in pollination control. We design and produce specialist pollination bags and tents used by plant breeders and seed producers all around the world. Through this, I've been privileged to get a unique perspective on how plant breeding globally affects our diets, farming systems, and the environment. I'm excited to share a little of this with you as we meet some of the amazing people who make plant breeding their life's work.

Hannah Senior: To close off series three, I thought we'd take a look at one of the most fast changing areas of plant breeding, the world of cannabis. So in this conversation, I'm talking to Dr. Greg Baute, who is the Senior Director of Breeding and Genetics with Aurora Cannabis. Greg talks about his early work in sunflowers and tomatoes and contrast this with working in a species, which has pretty much exclusively been grown on the black market for the last 100 years - just one of several characteristics that makes breeding cannabis such a different proposition to breeding pretty much any other crop. Transcripts of this episode and all our podcasts are available at www.PBSInternational.com/podcast. I hope you enjoy it.

[Theme music fades]

Hannah Senior: So, Greg, would you like to introduce yourself and tell us a little bit about your role?

Dr Greg Baute: Sure. So as you just said, my name is Greg Baute. So I work for Aurora Cannabis, which is one of the largest cannabis producers in the country, in Canada. We

have a sizable science effort and I lead our breeding and genetics team. That does exactly what it's described to do, right. We have a major breeding effort developing new cannabis cultivars and we also do, what I kind of think is the sort of foundational genetics work, the building blocks for letting us breed smarter. We also have this dedicated genetics team. That does all the, the GWAS and QTL type analysis that you would imagine.

Hannah Senior: And where are you located?

Dr Greg Baute: So Aurora is kind of made up of production facilities across the country, smaller companies that they acquired over the years, and headquartered in Edmonton. But I am on Vancouver Island in a town called Commack. We're at the geographic sort of center of the island.

Hannah Senior: I know you grew up very much surrounded by plants and plant breeding, albeit pretty unconsciously. Tell me a bit about that.

Dr Greg Baute: So I grew up in Southwestern Ontario on a seed corn farm. My parents not just farmed but produced seeds, so my summers were spent looking at inbred corn lines, and making hybrids, and looking at the hybrids. So it's just something that's been part of my life essentially forever. They founded the company the year I was born, so yeah, I've never really gotten too far astray from it.

Hannah Senior: So you literally grew up with plants and seeds all around you from day one.

Hannah Senior: Yeah. I've had a few like sort of like the occasional recurring awakenings to like, "wow, plants are so cool!" And "I should have known that more" but I guess I kind of took it for granted throughout my life. I went into Agricultural Science at the University of Guelph after I left the farm, I guess. Not really totally sure and then actually, because of required course in Genetics 101, literally, I took that class. It was the first one that really clicked for me, the first university course that really clicked for me, and got me excited. And I guess it kind of just cascaded from there.

Hannah Senior: You said you went to Guelph and you did Agricultural Science, and then you did the Genetics 101 and it sort of clicked like, "Hey, this is quite interesting." So how then did you get into focusing on plant breeding?

Dr Greg Baute: Yeah, so I ended up switching programs a couple times in undergrad as, as people kind of tend to. And again, and I think because of my childhood, I was aware of plant breeders existing, right? A lot of people don't even know it's a thing, right? Maybe have a vague idea that farms exist and that's where food comes from and I guess if you thought about it hard enough, there'd be those farmers who would have to get seed. I mean, we're just not taught that it goes all the way back up the chain, but of course we had breeders, my dad's friends with breeders and we had them at our farm all the time. So I started getting into more sort of Molecular Biology type stuff in undergrad. I did a Molecular Biology thesis project, but with a breeder.

Dr Greg Baute: So, it was in a plant breeders lab. Then after that, I moved to Vancouver to do a Master's at UBC, and that was largely a Bioinformatic master, so I was still sort of flirting with the more academic type side of things where I was still plant biology. Still kind of quasi, related to improving plants, but still sort of down in the weeds and, and molecular biology. And in that process I realized that I really would like my days to be spent looking at plants outside and not at a computer all the time and that sort of thing. So, I looked for more applied research projects for my thesis and that takes you to breeding, right.

Hannah Senior: But you decided quite early that you didn't want to be an academic. You didn't want to do it in a sort of theoretical sense. So tell me a bit more about that decision.

Dr Greg Baute: You know, even a couple years into my thesis, I was thinking “maybe I could do it”, because some of the most exciting plant breeding programs that I was aware of, at least at that point were public programs, were academic programs. So I thought, it'd be really cool. One day I asked my thesis advisor, Loren Rieseberg, about

what it's like, a day in the life of academia, and without hesitation, 100 percent, it's emails and writing! [He laughs] It's just all writing and editing all the time. He's an extreme example because he has a huge lab, and he writes and edits and contributes a lot of papers. But yeah, that is by far the least exciting part. Getting the formatting right on a paper so you can submit it, making sure your citations… Like all that stuff is just not interesting to me at all, so I wanted to make sure that I would again have time out in the field, looking at plants, being outside, which is the funnest part, really!

[They both laugh]

Hannah Senior: So you found yourself out in the field, not just out in any old field, but in a field of sunflowers. Which is certainly at some times of year, a particularly beautiful place to be! So tell me about that project.

Dr Greg Baute: Part of this really big initiative by the Global Crop Diversity Trust, which I think is now just called, The Crop Trust, was to essentially re-inject more genetic diversity into major crop species. So they had a list of 20 to 25, I forget exactly, staple foods for people that'll be affected by climate change. So it was part of an Adaptation to Climate Change project, and so for all of those, they wanted to essentially do what they called pre-breeding. It's essentially taking a wild relative, or an exotic, or a land race, and crossing them into elite lines. Doing some number of back crossing, and selfings, and evaluations to get them to a place where other breeders could use them more readily. So, in sunflowers, I ended up using about 25 wild relatives, some 12 different species, collected all across the US, that's where sunflowers are native to, and I made these pre-bed lines that were 5 to 10 percent wild and 90% elite, genetically speaking.

Dr Greg Baute: I made the lines and I characterized them, like when they would flower, the size of the heads, that sort of thing. And I also characterized them genetically, so “this one has an introgression from this species on this part of the chromosome”. I essentially delivered that package to breeders to be as useful as possible. I could have did selection for, for one trait or another, and maybe that would be great for the first breeder. But the next breeder actually would've liked to cap that diversity cap. So, it was

one of those trade offs where it's probably that some of the lines are not as pretty, or as useful as, as we would like. But maybe one in 10 of them have a useful trait that would have otherwise been lost.

Hannah Senior: Mm-hmm (affirmative). So by then, you knew you wanted to be in the field rather than behind a computer for most of your time, but your Masters was in bioinformatics and your PhD also had a really large bioinformatic component to it. Now, data, lots of it, is being increasingly leveraged in plant breeding, and you could argue, it gets more weight than field work does these days. What are your thoughts on that?

Dr Greg Baute: I know that there's been a trend by the industry, at large, to move more towards data, which is fine, but there's almost an idea that we can just do it purely with data, right. We can do AI enabled genomic selection, and it's going to be so much more efficient and we just need to throw computers, and genome sequencing, and markers, and it's going to be great and we don't need breeders anymore. But, I really think that you cannot do the breeding without the "eyes in the field" field work, but you could do the breeding without data.

Dr Greg Baute: And I know that's true because we did it for basically all of time until the last 20 years, without the data, 50 years, or whatever you want to do the timeline. We did it, most of it, without. That definitely works. You know, it still needs to be proven out that we can do it without that, with just data. So that might be a little bit outlandish sounding of a comment, but, I think in some places, the pendulum is swung too far. So I want to stand over on the other side and try to get it back to the middle a little bit more.

Hannah Senior: Okay. I'm going to skip on a little bit here after the sunflower project, you moved to California and took a job at Monsanto working as a trait geneticist, mostly in tomatoes. When did you start thinking about working in cannabis breeding?

Dr Greg Baute: I really didn't honestly think about it as a career path till around 2015, which is when I was in California. Kind of two things happened then, California, the

state, legalized recreational cannabis. And Canada elected a liberal government, which had essentially promised to legalize at a federal level in Canada.

Dr Greg Baute: Those things were kind of in my world, just kind of happened in the background and it wasn't until I basically ate lunch every day with a table full of plant biologists in California. And, in tomatoes, most of the stuff has been figured out, right? Like most of the big "whoa cool" experiments were done in the fifties, right? So the book was written. We were still doing cool projects and there's still stuff to work out, but it's squeezing out the last couple drops of new things from that.

Dr Greg Baute: Whereas in cannabis, it's an open book, right. There's just endless cool experiments to do, that's basically what we spent a good chunk of our lunchtime talking about was like, "what experiment could we do..." "isn't it interesting that it's photoperiod sensitive?" And it has all these interesting biology aspects, and we know nothing about the basis of them. Wouldn't it be cool to take this project that I did in tomatoes and do it on that? Or wouldn't it be cool to do this project than we did in soybeans and do it on that. So that got me more interested in cannabis.

Hannah Senior: So, you moved back to Canada. What happened next?

Dr Greg Baute: I actually was suggested by a friend to reach out to John Page, who was the founder and CEO of a then startup called Anandia, which I did. I joined an Anandia as its 25th employee, so it was a pretty small company then. Critically, it was almost all focused around testing. So the company was... John Page always wanted to do cannabis breeding as the big piece of the science that's required for cannabis. But what there was an immediate need for, and a sort of financial incentive for was testing. So all of cannabis that's produced in Canada legally is tested for aflatoxins and heavy metals and on and on. Pesticides is a big one because we want to ensure that we have a very clean product, and of course chemistry. So that was most of those 25 people we're working on testing as service, and then there was this just a half a dozen people that were starting the breeding effort.

Hannah Senior: Starting a breeding program with a plant that's been illegal in most parts of the world for well over a century must come with its own unique challenges. I know cannabis breeding has been happening over the years, largely underground, but of course, without the sort of scientific and genetic analysis that we expect from modern plant breeding programs. So what kind of traits were being focused on by the black market and what challenges did you face when it came to starting your program?

Dr Greg Baute: So they absolutely did a lot of work. Almost certainly, potency has been increased over the last decades by essentially what we can call them legacy breeders or hobbyist breeders or whatever. They've definitely moved the needle on a lot of things, but because they haven't been able to work in public space at all, it's not like there's pedigrees, right? It's not like there's germplasm banks where you can order the seed, right. It's a hundred percent, self-reported, names, it's a very mixed bag. Given that it's a clonal crop for the most part, there's essentially no homogeneous lines. There's no everything's hetero… Super, super heterozygous. You take the two best things from the Cannabis Cup and your favorite legacy, your favorite old line, you cross them together, germinate those seeds and see what you get sort of thing.

Dr Greg Baute: And then the other thing that is absolutely rampant in the cannabis seed industry is just straight up relabeling seeds, right? So Blue Dream wins a Cannabis Cup. Guess what? Every seed seller has Blue Dream seeds, all of a sudden. Right, right. They just...

Hannah Senior: Okay! By Magic?!

[They both laugh]

Dr Greg Baute: Yeah, exactly. So you have, and we see this in the data too, where we've sequenced hundreds of lines now, and five things labeled Bubba Kush, can be as different as any random five things. Right. The names, I would say are almost completely uninformative. Then in terms of getting the seeds into the legal market, into a licensed base there're ways to do that. There are provisions in the legislation to import

seeds. Essentially your given a grace period to import genetics. So that's how we can get it, get the stuff in, but it isn't easy. And what you get is, is essentially, I would just call it a bit of a grab bag. It's not ideal.

Hannah Senior: So characterization was a big part of the work early on then.

Dr Greg Baute: Yeah. I mean really starting, starting from scratch almost.

[Theme music fades up]

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[Theme music fades out]

Hannah Senior: So this is, you know, 2015-16, and it was kind of a gold rush wasn't it? You know, there was this massive expansion, very suddenly in Canada in certain parts of the US. So how did it feel to be in the middle of that? And did it affect the way that you were doing your job or your team was operating around you?

Dr Greg Baute: Yeah. There was a lot of things that happened in a very short time. So they, all the joke is that, it's kind of like dog years in the cannabis industry that like one year is like seven.

Hannah Senior: Mm-hmm (affirmative).

Dr Greg Baute: So one of my colleagues actually here just had a seventh anniversary in the cannabis space, which is like, well, you should retire! You're done, that's long enough! [They both laugh] Yeah, a lot has happened. So I joined actually January, 2018. And as I mentioned, I was the 25th employee. And then less than a year later, we were acquired by Aurora, which I think at the time was around 1200 employees and it

ballooned up to 2,500 employees. Now we're back down to some, I don't know exactly what we're down from there. And, we've acquired, well, we've - "the company" acquired a number of subsidiaries and merged them and moved people around.

Dr Greg Baute: So it's been, I would say super chaotic. We've been insulated, let's say from all of the volatility that happened. And part of that's just because of the markets are so volatile still. And it's been a little bit, I would say bittersweet, from my personal perspective, which is, I started, I went from the biggest seed company in the world to like a little startup and breeding team was me and Jack, right? [he laughs] It was like, that was it for breeding when I started. So I thought it was going to be super fun to like be a scrappy little startup.

Hannah Senior: Uh huh.

Dr Greg Baute: We had, we had raised money to build this greenhouse facility. In my vision it was going to be the sort of backyard "what I would do if I just raised some money to build a green research facility" which would be like the cheapest, everything possible. But with money coming in from Aurora, and money coming in from this sort of crazy market, we built out an amazing facility. Everything is top shelf. It's just a beautiful space, the greenhouse facility is really world class and it produces awesome plants. So it's like amazing space to be in. But at the same time, I'm back to a big corporation again. Which is fine, it just has its trade off. That's all.

Hannah Senior: Uh huh. Yes. Sort of swings and roundabouts, as you go through that process of large to small and back again.

Dr Greg Baute: Mm-hmm yeah, exactly.

Hannah Senior: So we've sort of touched on it a couple of times. This sense of the regulatory framework and it's really complicated. It varies from country to country and if you're in the US, from state to state, so how does that affect your work? If at all?

Dr Greg Baute: The Cannabis Act wisely included a provision, a whole separate licensing category for research facilities. So our day-to-day here in this facility is by no means unhampered, but it has a lot less of the overhead that production facilities have to face. So we can actually do our research, right? There's things that are at LPs at Licensed Production sites that would make research basically an impossibility. The level of scrutiny, inventory, security concerns, and production practices that you need to implement for the plant. What you can spray. What you can't spray. How much, all of that stuff, would make it very difficult to do our research. So thankfully there's this whole separate research license that makes the day-to-day of research possible. That said, it does start to cause some frictions when you go from a research license out to one of those... Like our whole scheme here is to be breeding new genetics to send to license producers.

Dr Greg Baute: Right. But you actually need to go through a facility with a nursery license to get stuff to production. So it's a whole other tier of stuff that you need to do, which again is, is fine. You need to essentially not quarantine, but clean or however you want to think about it, material moving out. All of that is just within Canada, right? That is just to get clones from here to a customer for production. If you add in international, it is like a multiplier effect in a serious way, right? [He laughs] I mean, it's basically our regulations, times their regulations, time the fact that unlike a lot of things, we're talking about shipping, living plants in a lot of cases, right. Not just seeds. So I mean, I'm sure you've spoken to breeders that lament the difficulties around phytosanitary certification for getting seeds, imported and exported, and you need this permit, and you need that stamp, and on and on.

Dr Greg Baute: You need the inspector to come, that's for seeds, we're shipping clones, so they're live plants. So the phytosanitary is even more complex, and they need to arrive alive, right?! (He laughs) You're going to put them in a Ziploc baggy, and put them in a cardboard box and send them to Europe, right. It's like, not trivial. Everything, they need to be received the next, all, everything needs to be super tight

and we're getting quite good at it. It's just going through the process, learning it. It's not straightforward, but it's all doable.

Hannah Senior: Mm-hmm (affirmative) Yeah. There's like a whole separate administrative skill layer that's needed to make sure that all of that works smoothly. That you wouldn't get, if you were back breeding sunflowers again, or

Dr Greg Baute: For sure, or critically, to talk, I hope I didn't come across as sort of trying to dunk on working for a big corporation because this is a case where it would be, if we were just that little 25 person team, it would be exceedingly difficult for us to have the sort of critical mass of knowledge and skill sets and everything to navigate this huge network of regulation. So that's been super, super great to have some of the most knowledgeable cannabis regulatory folks at our disposal.

Hannah Senior: So bringing it up to date, today, what kind of traits are you developing in the plants that you're working with? What are your priorities?

Dr Greg Baute: Cannabis is kind of weird because, well, it's weird in a lot of ways. [He laughs] One of the ways in which it's weird is that it has a ton of end points. So it has medical and recreational, and product that'll be sold as whole flower, milled, extracted, put in oils, or put in edibles. I kind of started off with a tomato or even a sunflower mentality, where it's like “each of these is going to be a separate purpose bred line”. So that means we need 16 different streams of breeding or whatever it multiplies out to. And gratefully, I’m very happy to report that I was very wrong in that assessment and that right now, the industry is at a point where there isn't differentiation at a genetic level of those inputs.

Dr Greg Baute: Certainly some things extract better and some things mill up better, but across the board, there's a base set of traits that everything needs and most stuff does not have right now. So we're working on establishing that. That's really first and foremost, it's about flower quality. So potency, THC or sometimes CBD needs to be as high as possible and consistently high that's a prerequisite. Then it's flower firmness,

color, aroma, how frosty it appears aesthetically, all of those things that make the flower good quality. Then secondary to that is how much it yields and the shape of it, all those things that are grower facing. So, it's unlike a lot of crops, where you worry about the growers' needs first and then the consumer second. Right? So yield, yield, yield maturity, that's kind of the lift most of the time. But for us right now, it's really about quality first. And then everything else follows after that.

Hannah Senior: Quite a lot of those traits that you just mentioned sound like they're quite subjective. So how does that work?

Dr Greg Baute: A lot of them are subjective. Some of them are, we know, linked. We can measure subjectively, and then we can back them up with call it, data on them. So I'll maybe make a toy example, you can measure firmness with your fingers and then you can measure a whole bunch, and then confirm it with the machine. And then you know that, okay, yes indeed, your hands are good enough at measuring firmness. But there's kind of two layers to your question, right? Like one is, is a person actually good at consistently measuring something? I certainly agree, that is a problem. And then the other layer, when you're talking about quality, is that, are we going the correct direction for quality, right? Like, “This plant smells musty or like cat piss”. Right. “So gross, throw it away!” “No, no, no. That's terpinolene. We love terpinolene.” Okay...? Yeah. It's like, “Wow. This one smells like garbage, but good!”

(They’re both laughing)

Hannah Senior: Okay! (sarcastically)

Dr Greg Baute: Exactly. Exactly. Well, no, and that's a whole class of cannabis is the cheeses. To me, they smell like cheese! They smell like bad stinking cheese. Don't want! No thank you! (laughing) So, with that in mind, there's kind of two, the big, well, one of the big areas for our science effort overall at Aurora is consumer and sensory work. So actually mapping what those traits are, being, setting up sort of expert panels of people who are consistently good at smelling citrusy, or smelling earthy, or smelling,

whatever it is, and then lining that up to what consumers actually like. Right? So, that's another whole piece of work that is being done and is really critical to enable all the downstream breeding.

Hannah Senior: But, I guess also you need to take into account the growing environment too. I know Aurora has different types of growing facilities all across the country, indoor, outdoor, greenhouse, but are you making selections based on the anticipated growing environments?

Dr Greg Baute: For the most part we're selecting for generalists. So we do evaluation in as diverse environments as we can. We also just like other breeding programs, we don't hand off, this is the one line you're going to use, figure out how to grow it. We'll say here's three, pick one, right? Here's three, they do a production trial. See which one performs the best. And then after that, it's a lot of tweaking to get it pretty close. And we've definitely seen our facility that we're breeding in is a green house that was designed following our big production greenhouse. So not universally, but overall, the things that we breed here do better at the greenhouse facility than at our indoor facilities. But it's small variances. It's not anything that we can't overcome with good cultivation.

Hannah Senior: Another thing that sets breeding cannabis apart from many other breeding programs is the time scales. Patience is a key word among most plant breeders, but in cannabis breeding, things can happen really fast. Do you want to just dig into that?

Dr Greg Baute: Yeah. I mean, for perspective, I finished my thesis in 2015 and all of my lines are deposited at the USDA and I know that they've been accessed by several different breeding groups around the world, and I would be flabbergasted if any has been incorporated into commercial products yet. So that's six or seven years later. Two years ago, two and a bit years ago... Well, two years ago, this was still a construction site and a year and a half ago, we got our license to grow plants. And we already not

only have new varieties that were bred in house in production, but they're already on store shelves.

Hannah Senior: Right. Wow.

Dr Greg Baute: Like the whole breeding cycle will be around two years from initiating the cross, to having product on the shelves. So it's insanely fast for plant breeding, like totally ludicrous speed.

Dr Greg Baute: And there's a couple of factors that go into that. One is biology, right? So it is annual, but it's clone. Right. And I think with the exception of some ornamentals, I don't think there's many other annuals that we clone. So that lets you “this plant, this individual plant is good.” You can just multiply it, multiply it, and multiply it and get up to production quantities really in more in the order of weeks than months. You can do it really rapidly. So, that's one factor. Another factor is that the competition in a sense is low. So, nobody's had a breeding facility at this scale before it just hasn't existed. So we're doing orders of magnitude more powerful selection. We're going, I'd like to think at least we're going to really outpace the current cultivares in a very rapid fashion.

Dr Greg Baute: And all of our growers and consumers are going to want to see them replaced with these new ones because they're going to be that much better. And that the last bit is that the cannabis market itself it's not currently at all like beer. Where like most beer drinkers just drink Budweiser and they always get Budweiser. They always get Blue or whatever, and that's their beer. Cannabis really seems to be, every time somebody goes to a shop, they're going to get something different. Right. And so that means every couple of months we need new products on the shelf. So that's great for plant breeding, right, that's the ideal, that's the dream, right?! (they both laugh)

Hannah Senior: Keeping you in business! (she laughs)

Dr Greg Baute: Yeah, totally. For a lot of crops, even clonally propagated crops, it is very difficult. Especially consumer facing ones like apples. I know it's super painful to get growers to commit to a new variety because you don't know what the market's like.

In cannabis, we can do a production run of a new variety and see if consumers like it and then produce more accordingly in the scope of six months. Right. So it's great. It's great that way.

Hannah Senior: Where you are right now, what is it attracting your interest and energies either within cannabis or beyond that?

Dr Greg Baute: Yeah, in cannabis, we are just at the end of a growing cycle now. My main… One of the things that really gets me excited is figuring out how to grow cannabis outside at scale in Canada. Right. So, yeah you can grow cannabis outside in California. No problem. We're not California. It is not the same thing! (laughing) We need very different technology and different cultivation practices. So that's something where I've put a lot of effort and we're breeding very intensively for, because I think it's really important. It's going to save producers a lot of money and it's going to be much less impactful on the environment, right. These indoor facilities and greenhouses, they produce an optimal environment for the plant, but they also, they do that by consuming a lot of energy. And as long as energy's made with fossil fuel, that is no bueno, in my opinion. So yeah, that's the one thing that really gets me excited about cannabis or well about the breeding work.

Hannah Senior: And if you think back over the trajectory of your career, if you were doing it over again, is there anything that you would do differently knowing what do you know now?

Dr Greg Baute: Yeah, I thought about this question and I don't know! (he laughs) I'm really happy. I mean, you couldn't, I couldn't ask for a better, better place to be. I mean, the, facility and the team here is totally awesome. So I'm really happy with where I've ended up. Yeah. I don't, I don't know how to answer that question.

Hannah Senior: You're happy! That's a good place to, that's a good way to answer it.

Dr Greg Baute: Yeah. Thesis work was awesome. Current job's awesome. And everything in between any bumps or valleys in that, maybe I wouldn't have ended up

here. So, you know, not to get too philosophical, but maybe I wouldn't tweak anything so as to not risk this.

Hannah Senior: You might have ended up somewhere else if you tweaked it along the way.

(They laugh)

Dr Greg Baute: Yeah, exactly. Exactly. Yeah, no, I mean, there was definitely forks in the road and I could have ended up going a very different path. So I'm not going to complain.

Hannah Senior: It's been a really interesting conversation. I think it is a unique moment in time to be a plant breeder, to be a plant breeder in cannabis. So thank you very much for sharing it with us today. Dr. Greg Baute. Thank you.

Dr Greg Baute: My pleasure. Thank you.

[Theme music plays]

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[Theme music fades]