Sawbones 226: Genetically-Modified Organisms

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[theme music plays]

Justin: Hello everybody, and welcome to Sawbones: a marital tour of misguided medicine. I'm your cohost, Justin McElroy.

Sydnee: And I'm Sydnee McElroy.

Justin: Well, Syd.

Sydnee: Yes, Justin. Were you waiting for me? Because typically you talk first.

Justin: I do talk first, but I don't know what to say. I'll say this. I don't know that I've ever seen you research a topic as much as you researched this one. Seems like for the past week, any time I asked you, like, "Hey what are you doing?" "I'm researching."

Sydnee: Well, I knew this one was going to be controversial, and I wanted to make sure I understood all sides of the controversy and that I could explain it well.

Justin: Okay. Now I'm on pins and needles. Don't keep me in suspense anymore.

Sydnee: So, we're gonna do this. We're gonna take on GMO.

Justin: Okay.

Sydnee: Genetically-modified organisms.

Justin: See, you've already put yourself in a conflict position by saying we're gonna "take on". Maybe we're just gonna have a free-wheeling, chill discussion about genetically-modified organisms.

Sydnee: Listen Justin, I thought at one point on this show I was gonna have a just chilled out, free-wheeling conversation about fluoride and what happened? [laughs]

Justin: Look where that went. We still can't shake that.

Sydnee: I still get emails. No, there's a lot of misinformation surrounding GMOs, there's a lot of misunderstanding. And I feel like this is one of those areas where science— sometimes scientists have difficulty communicating what they're doing and why they're doing it to lay people. Because it's complicated and it's science-y and we use a lot of jargon, and there are ways to explain it and sometimes people just don't take the time, or they don't know exactly how to communicate that. And so then you get a lot of confusion and fear.

Justin: Okay.

Sydnee: And I know GMO seems like a food thing. Like, most people think of GMO as produce and things like that are GMO, but there are many medical applications already, and future, that are being done. So this is a very medical topic.

Justin: Okay, great.

Sydnee: Alright. So, do you know what a GMO is? A genetically-modified organism. Do you know what it is?

Justin: Yes. But I'm very smart.

Sydnee: Do you wanna explain it, or would you like me to do that?

Justin: Why don't I try? Usually a good way of handling this is I try and then you sort of build upon the very solid foundation that I have laid.

Sydnee: Build upon? Sure. Go for it.

Justin: Um, genetically-modified organism is an organism that's— I mean, it's right there in the… that part's…

Sydnee: Yeah. You used one of the words in the definition, which I think is frowned upon.

Justin: A living thing, that's an organism.

Sydnee: Uh huh.

Justin: A living thing that has had its core DNA altered, either through gene splicing or through selective breeding.

Sydnee: That's pretty good, Justin.

Justin: Thanks Syd.

Sydnee: That's very good.

Justin: Thanks.

Sydnee: Yeah. I mean, that's basically— if you've altered the genetic code of something, it has become a genetically-modified organism.

Justin: And I think the only, sort of, other thing that I would say is like, the name implies a— there's obviously, like, evolution dictates that there is genetic modification happening constantly in our environment.

Sydnee: Yes.

Justin: When we say GMO, we tend to think man-engineered.

Sydnee: Artificial.

Justin: Yeah.

Sydnee: Yeah. And there are— do you know how we do it?

Justin: Like, honestly Syd? The selective breeding, sure.

Sydnee: And I'll get into what selective breeding is, and artificial selection and that kind of thing.

Justin: I can kinda guess that. The gene splicing thing, every time I think about it, I think about a very tiny knife. [laughs] Just has like, some part cut out of it. I have literally no idea about that part.

Sydnee: Well, that's the thing. So, we're taking DNA from one thing and putting it into the DNA of another thing, right?

Justin: So blood? Take blood out and put it in…

Sydnee: [laughs] There has to be a way to cut up the DNA and put new pieces of DNA in there, right? You can't just do that by, like, stirring it together. You don't just dump all the DNA in a beaker and swish it around and you get new things, that doesn't work. The ways we tend to do it are we use things that naturally, like, they already cut up DNA and insert things into it. That's what they do. The most common examples are viruses or bacteria. Part of the way they infect things is they get inside a cell, they get into the DNA, they cut it up and put their DNA in there, and then sometimes that will make the cell start making more viruses or bacteria or whatever it is. Or certain proteins, whatever it wants it to express. So we know that these things already exist, so we have used these as vehicles to alter DNA intentionally.

Justin: Okay.

Sydnee: Does that make sense?

Justin: Yes.

Sydnee: Because then we can put the DNA we want into the virus or bacteria, it will introduce it into the cell, put it in there, and then it starts producing whatever we want it to do.

Justin: Okay, got it.

Sydnee: That makes sense? There's also a gene gun.

Justin: Nice. That's so rad.

Sydnee: That exists and it shoots these little particles that are coated with DNA into a plant cell.

Justin: That's wild.

Sydnee: Yes, that is wild. I'm not gonna focus on that as much.

Justin: Shame. That seems ill-conceived, Syd.

Sydnee: [laughs] So, the first question would be why do we GMO? Why do we do this?

Justin: Um, I think, well, I could guess, for like, produce we want stuff that's like, bigger and juicier. If it's supposed to be juicy. If it's not supposed to be juicy you do not wanna select for juiciness.

Sydnee: No.

Justin: But like, that kinda stuff? Like, good?

Sydnee: To make something meet our needs better.

Justin: Right.

Sydnee: So, make a crop hardier, make a tomato tastier, make a bacteria that breaks down pollutants. There's something interesting. And then there's some more medical applications though, that we'll get into.

Justin: I learned in Moana that all of these things are here for our pleasure and enjoyment, so shaping them makes perfect sense to me.

Sydnee: See, this is the view that— that is a very negative view of this.

Justin: What?

Sydnee: And I'm gonna tell you why this is a very negative view of this. Because this is not new. That idea, what you just said, like that animals and plants are all here for our pleasure and for us to shape to meet our needs—

Justin: Yes, and name. We get to name them too. Kinda big.

Sydnee: I don't know that all of our listeners would necessarily agree with that viewpoint. Or find it pleasant.

Justin: I'm just saying what I learned in Moana, Sydnee. Approved workmen are not ashamed. I'm just telling you what I learned in Moana.

Sydnee: Now, we have been trying to grow the best crops and breed the best animals for thousands of years. We have evidence of this as far back as 32,000 years ago, when in East Asia wild dogs were selectively bred to accompany hunters. Hunters found them and liked them and some of them were nicer than

others, so they took the ones that were nice, hung out with them, bred them with other nice dogs and eventually they became, you know, corgis or whatever. Like, eventually we got dogs.

Justin: Got it.

Sydnee: That's how that happened. They were wild dogs, they were wolves, they were artificially selected for a trait humans enjoyed. We liked the nice ones. So we kept the nice ones.

Justin: Not too nice. Because they were still, like, hunting partners, right?

Sydnee: Well, eventually they got really nice. I mean, some dogs are quite nice, I am led to believe.

Justin: Some boys are good. There are some good boys.

Sydnee: [laughs] I don't have a dog, but some of them are nice. So, we've been doing that. That's called selective breeding, or artificial selection. We take things that we like and we breed them and then we get more of the thing that we like, right?

Justin: Right.

Sydnee: That makes sense. This works. It just takes, you know, thousands of years for that to work. You're not gonna take a slightly docile wolf and another slightly docile wolf and breed them together and get a pet. It's not gonna happen in one turn. It's gonna take a long time.

Justin: And they only had, back 32,000 years ago, they probably only had a few gene guns to go around.

Sydnee: [laughs]

Justin: So they had to make use of what they had.

Sydnee: They had to do things the old-fashioned way, J-man.

Justin: Oh no.

Sydnee: You know what I mean.

Justin: Yeah.

Sydnee: Yeah. Let's not go there [laughs]

Justin: Yeah.

Sydnee: So, plant artificial selection probably dates back to 7800 BCE, with wheat crops. That was probably the first time that people started picking things that grew better and replanting that. Does that make sense?

Justin: Yes.

Sydnee: Yes. I mean, that's basically what you were looking for, the plants that grew the best or tasted the best or made the best whatever you're trying to make with them. And this is where we have evidence of that happening. But probably a better example if you wanna see how selective breeding and artificial selection from thousands of years ago has borne out effects now is corn. So corn, originally, where it comes from, corn that we like, that we eat, that's sweet and yummy and inexplicably zero points on Weight Watchers. Corn was originally a wild grass called teosinte. It had these teeny little ears with just a few kernels on each one.

Justin: Aww. So it was a baby corn.

Sydnee: Over time, from us taking the ones that were bigger and had more kernels and bigger ears and breeding those together, over time we have introduced these giant, yummy ears of sweetcorn that we eat now.

Justin: Okay. That was good. Good job us.

Sydnee: So that is thousands of years of evolution of corn from us selecting what we like. And there was no malicious intent, like, "I'm gonna breed out of existence this wild grass," it was just, "I like this sweet corn, I wanna keep growing that." And that's how that happens.

Justin: No but listen, but let's— listen y'all, somebody was like, bummed out about the wild grass. It was pointless.

Sydnee: I assume. I don't know.

Justin: I would like to see one of those tiny, ridiculous ears of corn. Just, with my own eyes. I do miss that. I wish that wasn't extinct, but other than that.

Sydnee: [laughs] Corn is one example. Over time, we know that apples are sweeter than their predecessors were, because we like sweet apples. Broccoli is larger, because it was easier.

Justin: [laughs] We like big broccoli.

Sydnee: [laughs] We like big broccoli.

Justin: A big old broccoli.

Sydnee: Well, imagine the effort it takes to grow broccoli. I mean, not that broccoli's particularly hard, but like, if you're a farmer and you're growing something and it produces this teeny, teeny, little head of broccoli and that's it, if you can find a specific plant that has a much bigger head and you think, "Well, I'd rather grow a bunch of those, because then I have more to eat," and eventually more to sell, or trade or whatever era we're in, when we were bartering or whatever.

Justin: Barter with, yeah.

Sydnee: So you can see where that would happen. Now, all of this that we're talking about, again is, while I'm using the word artificial, seems natural. Right?

Justin: Mm-hmm.

Sydnee: Because nobody's doing any— I think as soon as you take something into a lab—

Justin: I mean it's obviously not natural, but I know what you're saying.

Sydnee: Well, it seems— I think it's a lot closer, like a lot of people would accept that as, "Well, that's just what happens." Natural selection and artificial selection in this sense, I mean, the only thing that's artificial about it is we're introducing humans.

Justin: And we're natural.

Sydnee: Well, we're part of the food chain, too.

Justin: Right.

Sydnee: But I think that we can accept that this is gonna happen on a certain level. So, in 1973 is when we first start what we kind of think of now as GMO. Where I think people start to get concerned and worried about the genetic modification process. So Herbert Boyer and Stanley Cohen figured out a technique in 1973 that would lead to everything that we know about GMO now. They were working with bacteria and antibiotic resistance. So we know that certain bacteria cannot be killed by some antibiotics, right? They're resistant to them. They were able to find the gene in a bacteria that gave it that resistance. This is the gene that once it's turned into proteins protects the cell from that antibiotic. If we take this gene out of this bacteria and put it into a different bacteria that usually is killed by that antibiotic, can that bacteria become resistant as well? That was the question. Can we do it and will it work? And it did. And this was the beginning of GMO technology. Now, I know that seems really crazy. Why would we want to make more bacteria resistant to antibiotics?

Justin: Right.

Sydnee: Obviously that was not the— that was an example.

Justin: Because we're humans and we just do things.

Sydnee: No, there's a reason why this was very helpful. It's a marker. If you have done all this splicing, how do you know that it worked? You've got a bunch of cells now in a petri dish. How do you know that they have the DNA that you want in them?

Justin: Oh, you can introduce some antibiotics.

Sydnee: Yes, and if they are resistant then you have introduced the DNA. So, if you introduce that antibiotic resistance gene with a gene that's helpful, then you can test it to see if it worked by applying the antibiotic. So that's why, it's a marker.

Justin: Right.

Sydnee: Okay, so this is done a lot, and that's why that's done. I think that's important to understand. So, another scientist who eventually would become a Nobel Prize winner, Paul Berg, was working with slightly different genetic modification. Because all this research was going on at the same time. They were the first two to figure it out, but a lot of different scientists were trying to figure out, "How can we move DNA from organism to organism?" So he was working

with something called Simian Virus 40. This is a virus that causes cancer in rats. Okay? It did so by infecting a cell and putting its DNA into the cell's DNA, which obviously is what we're trying to do. So, if you put the genes into the virus, it will also insert those into the infected cell, just like we kinda thought would happen.

This was very exciting because they were doing these experiments and it was working. But it scared a lot of people when you started talking about a cancer-causing virus that you're putting into somebody's— I mean, in this case we're not putting into anybody's body. But theoretically this would be the applications of this, right? Use this virus as a vehicle to introduce genes into something. And then how does that affect humans? So, from these experiments, a lot of fear started to arise.

Justin: Yes.

Sydnee: What are we doing, why are we doing it, and if we're going to use a virus that causes cancer in rats as a vehicle to deliver genes, could it cause cancer in whatever we're delivering it to?

Justin: I think that's a legit concern.

Sydnee: Perfectly legitimate concern. So legitimate that by 1974, scientists themselves, the scientists who were doing these experiments, agreed to a worldwide moratorium on GMO research until they came up with some rules.

Justin: Is there a precedent for that, do you think?

Sydnee: Not that I could find.

Justin: Yeah.

Sydnee: Everybody agreed, "Wait."

Justin: "This is wild."

Sydnee: "This is wild, let's talk about what we're doing before we move forward." So, they put together this huge conference. The International Congress on Recombinant DNA Molecules. Recombinant DNA is when you take DNA and—

Justin: Hey guys, hey guys. Good name. [laughs] Good job.

Sydnee: [laughs] Is when you take DNA and put it into something else. That's recombinant DNA. That new DNA you've inserted. So, they put together this huge

conference in Pacific Grove, California. It's now mainly know as the Asilomar Conference, that's where it was held. Was like, the conference hall. In 1975. And they came up with these rules and it was all based on tiers of risk. Like, what you're doing isn't particularly risky, so you have to use these precautions. You're messing with cancer viruses, that's really risky, you have to use all these precautions. So they came up with all these tiers and all these rules and these are still the basis of all the guidelines we use to guide the research we do now. So, scientists themselves said "Let's take a step back and make sure we know what we're doing."

Now, since then we've had countless experiments using genetic modification all over the world. And since then, we've also discovered— and so far, there's no evidence that any of them have gone awry, because they've used all these guidelines and safety procedures and testing, double-checking and all that. And they've also discovered something new. This happens in nature all on its own.

Justin: Okay.

Sydnee: Lemme give you an example of what I'm talking about. About 8000 years ago, there was a bacteria called agrobacterium. This is still the main bacteria we use for this research today. It infected the root of a plant, and when it did that, it inserted some of its bacterial DNA into the plant DNA. Okay? Just naturally, that's what that bacteria just did.

Justin: Okay.

Sydnee: This made the roots swell really big. It also made it really starchy and sweet, and once humans found it, very edible. Enjoyable. People really liked it. They loved these big yummy roots so much, they started—

Justin: [laughs] "I love these big yummy roots!"

Sydnee: [laughs] They started planting them again, all over the place. Clippings spread around the globe, everybody wanted to plant these yummy roots. Eventually, this plant became the seventh most important food in the world, according to the UN. It was like a staple crop. In the US, we mainly associate it with Thanksgiving, but in some parts of Africa this is something that feeds people year-round. It's the sweet potato. The sweet potato is naturally GMO and scientists are trying to figure out what all changed from the original one. They can't find a sweet potato around the globe that doesn't contain this bacterial DNA.

Justin: And now you know the rest of the story.

Sydnee: [laughs] So, the sweet potato is GMO. It just naturally is GMO. It's got bacterial DNA in it. And we've been, I mean, that's all sweet potatoes everywhere.

Justin: So if someone says non-GMO sweet potatoes, they're lying to you.

Sydnee: It just is. Blame the bacteria. We didn't do it. We just liked it and kept eating it, and there you go. On the non-medical front, since we've been doing all this research we have used GMO to bring us bacteria that break down oil in 1980. I think most people have kinda heard of that.

Justin: Yeah.

Sydnee: That there was a bacteria that could help break down oil in oil spills. There was a tomato called the "flavr savr" that was introduced in 1987.

Justin: It is a— I'm looking at your notes here. It's a bad spelling, y'all.

Sydnee: Yeah. Yeah, it is.

Justin: Like, it could use a few more vowels in there.

Sydnee: It was supposed to be firmer and more shelf-stable than other tomatoes. I don't think it was very successful because people got freaked out by it.

Justin: F-L-A-V-R S-A-V-R by the way, in case you're curious. It's rough.

Sydnee: [laughs] I don't know that its flavor actually changed, I think it was just firmer and more shelf-stable. But whatever. I guess it tasted better longer because it didn't rot. In that sense. Anyway, there's a kind of corn called Bt corn that produces pesticides, that came out in 1996. So obviously corn that kills the pests that would eat the corn.

Justin: That doesn't sound very appetizing, I'll be honest Sydster, but okay.

Sydnee: And a new apple, this was introduced pretty recently, called the arctic apple, that doesn't brown. Or at least, it browns much, much, much slower. And I know that sounds like a silly thing, like, so you just made one that looks more aesthetically pleasing, but how many people throw out browned apples unnecessarily?

Justin: A lot of them.

Sydnee: So the idea is that we're cutting back on food waste, if we make humans not so afraid of apples.

Justin: That would be a good thing in the McElroy household, where we frequently buy produce and think, "Yeah, for sure. Gonna eat all of these fruits and vegetables."

Sydnee: [laughs] Well—

Justin: And then when you open the drawer, it's like, "Oh no." [laughs]

Sydnee: An apple hasn't necessarily gone bad just because it turns brown, but everybody throws it out.

Justin: Right.

Sydnee: So something to decrease that would make people throw them out less and eat them more and everybody wins. And I'm gonna get into, by the way, there's obviously a second part to this episode where I talk about all of the controversy surrounding things like corn that produces pesticide and stuff. But I'm just giving you some examples of what GMO has brought us. On the medical front, genetically-modified organisms and the technology that surrounds it has brought us Humulin, which is a kind of insulin, in 1982. Prior to that, we had to use pig insulin. We made our own based on human insulin. We made human insulin, artificial human insulin, this way.

Justin: Cool, good job.

Sydnee: Which is less likely to cause an allergic response than using another animal's insulin.

Justin: Cool.

Sydnee: The bacteria E. coli was used for that.

Justin: Better for pigs, too. They can finally get back to enjoying those sweet treats.

Sydnee: [laughs] It was the first recombinant medication on the market. That was the first time we used GMO technology to introduce a medication. More recently, we've given goats the ability to produce milk that contains antithrombin. So, some people have a deficiency of a certain clotting factor.

Justin: Okay.

Sydnee: Okay? [laughs] Not of clotting factor, anti-clotting factor, I should say. It breaks up clots.

Justin: Okay.

Sydnee: Okay? Some people don't have it.

Justin: So they get clots.

Sydnee: Yes. So, we have put DNA into goat cells that makes them produce milk that makes antithrombin, that we can then give to humans. Does that make sense?

Justin: Okay… I just think it's so wild, that it's like, "I gotta solve this clotting problem. Wait a minute, I got it. What if the goats… "

"Let me stop you there."

"No, no, no, hear me out. What if the goats made a special milk that fixed it?"

Sydnee: [laughs]

Justin: Like, why? That seems like quite the leap, but okay.

Sydnee: They figured it out and they made the drug A-T-R-Y-N. ATryn. I don't know how you're supposed to pronounce that, but the point is you get their milk and you take this drug out of it and you can give it to people who need it. It's not an incredibly common condition, but if you have it, you need medication for it.

Justin: You'd be happy about those goats.

Sydnee: It doesn't hurt the goats, by the way. The goats seem fine. As far as, I mean, as far as I can tell.

Justin: Cool. They're just happy to help. Goats feel really indebted to us, they really are just pleased to be able to contribute. [laughs]

Sydnee: [laughs] We've made a medication—

Justin: I mean, they eat our cans and they're happy to do it, but…

Sydnee: We've made a medication called EPO Alfa, which is used to help simulate red blood cells for anemia for certain reasons, and we've made Avastin, a cancer treatment, using this technology.

Justin: Do you know that if goats eat poison ivy then their milk can give you immunity to poison ivy? Elizabeth Gilbert told me that.

Sydnee: Really?

Justin: Yeah. True.

Sydnee: I don't think I knew that.

Justin: Travis— we talked about it on MBMBaM once, the very good joke Travis made is that if a goat eats your passport, it can give you diplomatic immunity.

Sydnee: [laughs]

Justin: Which I thought was very good.

Sydnee: That is good.

Justin: But anyway yeah, I dunno, it's farm wisdom so it may be a bunch of hokum. Anyway, it sounds like GMO is good.

Sydnee: Well, I want to get into why— all this sounds great, so why are people so afraid of it?

Justin: I dunno, man.

Sydnee: Well, we're gonna talk about that.

Justin: Okay.

Sydnee: But first, let's head to the billing department.

Justin: Let's go.

[ad break]

Justin: Alright Syd, so you alluded to the fact that there is obviously some controversy tied to GMO stuff, so do you wanna get into that?

Sydnee: Yes. I'm going to get into the controversy, and then I'll give you some sides of it. So, the criticism of this— and to sum up where we are, is that we figured out a way to take DNA from one thing and put it in another thing. And we are finding applications for that in medical science as well as food and industry and many other places, right?

Justin: Right.

Sydnee: So, while so far, as I've mentioned, nothing has proven dangerous. We don't have cases of people eating flavr savr tomatoes and having bad reactions, these medications are like any other medications, they have risks and benefits and they work and there are people that shouldn't take them and, you know. They're like any other medicine we make, ever.

Justin: Right.

Sydnee: So, so far we don't have catastrophic results from all this research we've been doing since the 70s, right? But there are still questions. Obviously the scientists themselves realise that, because they agreed initially to stop what they were doing and figure out the best way to do it. So, the more we do, the more we learn, but there is fear there. Here are some questions. If you use this antibiotic resistance marker that I talked about, could you make a bunch of bacteria resistant to antibiotics accidentally? And then we infect ourselves with that bacteria accidentally, and then we have created an antibiotic resistant plague. Is that possible? I mean, so far we haven't done it.

Justin: Probably.

Sydnee: No, it's not probably possible, but is it possible is a fair question, I think. Could you make something an allergen? If you put DNA from one thing into another thing, and you're allergic to the original thing, are you now allergic to this new thing?

Justin: I don't know.

Sydnee: That's the question. Or, maybe you weren't allergic to either thing, but now that you've put them together, you've created an allergen. Is that possible? And what about, if we're talking about food, is it less nutritious? Justin, you asked me that question.

Justin: I did, I didn't know.

Sydnee: Yeah, is it less nutritious if you make it through GMO? If you put DNA into part of it, will it disrupt the DNA around it so that it doesn't create the same things it did before? Is it bad to eat unnecessary DNA? Can you ingest too much DNA? Is there a problem with DNA?

Justin: I would say probably not. That sounds wild.

Sydnee: These are all questions that have resulted from this, and I will tell you that so far, the answer to these questions is no, everything seems fine. We haven't seen these problems. We have not— the idea that we're going to introduce this antibiotic resistance as a marker and it's going to erupt from the lab, first of all we'd have to use bacteria that were disease causing, which we generally don't, and, I mean, there are so many safeguards against it. The examples of the allergens, that's why all the safety testing, that's why that conference and all the safety testing that resulted from it, that's why that exists. Is because there have been cases when in a lab we have seen some allergic responses to new products in animals. So they were never released. The safety testing works. That's why.

And that's the same for anything we do in science, right? Before we put it into humans, we make sure that it's safe. So there are lots of things that aren't failures, because we tested a medication or a vaccine or something out in a lab, found that it didn't work or it caused harm, and it never made it out of the lab. That's science for you. So far, we don't think there's any reason to fear eating DNA. You eat DNA all the time. If you eat anything. Plant, animal, anything.

Justin: I love DNA.

Sydnee: Yeah, DNA's in there. So don't worry about that. And if you're going to make the argument that you could make food less nutritious accidentally, you have to make the argument that you could also make food more nutritious accidentally.

Justin: [laughs] Right.

Sydnee: Because we have no idea, I mean, that's what you're saying, you don't know what it's gonna do. Well, if you don't know what it's gonna do, it could make it more nutritious.

Justin: That's true, yeah.

Sydnee: So, so far these things haven't borne out. But it's fair to ask these questions. I think that's perfectly— that's what science is all about. Asking, "What will happen if we do this?" And then testing and double checking and triple checking and figuring out what the answers are. One argument I would make on the positive side for GMO stems from Norman Borlaug. Now, you know who Norman Borlaug is.

Justin: I do.

Sydnee: Do you wanna tell everybody who he is, in case they don't know?

Justin: He was… I found out about him because I think we watched an episode of Bull…

Sydnee: The Penn and Teller show with the name that has a curse in it that we can't say. [laughs]

Justin: Can't say.

Sydnee: Bullcrap.

Justin: A Bullcrap about GMO stuff, and he was a scientist that, I guess he created— he found a way to use genetic modification to, like, feed lots and lots of people.

Sydnee: So he didn't actually use genetic modification. He used the old fashioned method.

Justin: Selective breeding.

Sydnee: Selective breeding. So, he took a bunch of different wheat strains and bred them together to, like, 6000 different crosses of wheat before he was able to— what he was trying to do, he was a geneticist and pathologist, he worked back in the 40s, and he was trying to make wheat that was disease resistant and would grow better. To help feed starving populations. That was the reason. There are parts of the world where people are starving. He was trying to help feed them by making a hardier wheat that was resistant to disease.

And the big problem is that they were long stalks, which are good because long wheat stalks can get more sunlight, but it's bad because the tops would get heavier as they grow too fast. Because his fertilizer was actually really good too, so it made them grow really fast and, but then the tops would get heavy and they'd fall over. So he helped make these dwarf wheat strains, like that would be really short and hardy and grow really fast and feed more people. So, he did this. This was obviously very successful. The yields in the fields where he grew this wheat doubled as a result of all this, meaning that he could grow more wheat per square acreage or whatever of farmland. Right?

Justin: Right. Especially important in areas where there's not as much, like, choice.

Sydnee: Arable land.

Justin: Arable land.

Sydnee: Yeah, exactly. And the other part of that is if you can increase the yield per acreage of arable land, you don't cut down so many trees to get more farmland. So you help— one of his big pushes was to help fight deforestation. It's not good to go wipe out a forest so you can grow more wheat there. Instead, let's get more wheat from the land we're growing it on. That was his hypothesis. So anyway, he did this, he won a Nobel Prize for it in 1970, he greatly improved food security in places like India and Pakistan, he probably saved a billion people from starvation worldwide.

Justin: Probably the best person. Like, you could make an argument for, like, the best person.

Sydnee: He's one of the unsung heroes of history. I mean, he is sung, but not enough, Let me say that. Under-sung heroes of history.

Justin: Right.

Sydnee: Yes, he has saved, like I said, a billion people from starvation. Now, he did it, like I said, using the old-fashioned method. He crossed different wheats until he figured out what this best hardy wheat was. But he has said we have to figure out a way— his solution to world hunger was increased crop yield. You have to get more food from the land you already have. The solution is not to cut down more trees and get more land. And this is important because it is expected that by the year 2050 we're going to need 70% more food to feed the world population. I've seen estimates that, like, by 2100 we could have 11 billion people on the planet.

Justin: Right.

Sydnee: We need more food. You're either gonna cut down more trees or hope the population decreases, which, that's a terrible thing to hope.

Justin: That's not nice.

Sydnee: No, let's not hope that. I mean, that's really what people have said. Either that, or we have some sort of plague that wipes out a big swathe of the population, then we don't need to feed so many people. Or, we figure out how to get more yield from the land we've got. And he has said GMO is the way to do this. The more disease resistant crops we have, the more faster growing, higher producing crops you've got, the more people you feed, and you don't have starvation. So that's on the positive end. On the negative end, I would draw attention to Monsanto.

Justin: Yep.

Sydnee: Now, most people have heard of Monsanto kind of just vaguely as this, like, big scary corporation that does bad things.

Justin: Correct.

Sydnee: And doesn't know all the details. And I had to read a lot about Monsanto to figure out the whole— I was kind of in that camp. I'd seen them in a documentary. [laughs] So, a lot of the criticism of GMO gets kinda tangled with criticism of Monsanto. Monsanto is a corporation that's actually been around since 1901. It originally made food additives, like it put caffeine and saccharine in things. Now they're an agrochemical and biotech company, and they developed an herbicide called Roundup. You've probably heard of Roundup.

Justin: Sure.

Sydnee: They then made a GMO plant that was resistant to Roundup.

Justin: Good.

Sydnee: So, it was called Roundup Ready seeds.

Justin: Okay.

Sydnee: So now— and they patented both. So now you have seeds that will grow something that won't be killed by Roundup, and then you sell the Roundup to people so you can kill all the weeds around it. So you can see where people—

Justin: Scummy, but, like, capitalism.

Sydnee: Right, you can see where people are not thrilled about this.

Justin: Sure.

Sydnee: And since then, they've been expanding the kinds of foods that are GMO, and they've been met with a ton of controversy as a result of this, Now, some of this is over their business practices and concern about environmental impact. They sell you seeds and you have to buy new seeds every year. You can't just replant the seeds you get from the plants you grew last year. They will fine you for that. It's illegal. And so, they're really strangling farmers if, for instance, a drought happens and they lose their whole crop.

Justin: Right.

Sydnee: Then they don't have any money, and maybe they owe Monsanto a bunch of money and they can't buy new seeds and it's, I mean, obviously we see the problem there. If your seeds get mixed up with non-GMO seeds, let's say you're a farm that doesn't wanna grow GMO food because now there's been so much backlash, there's a lot of negative publicity, so you don't wanna grow GMO stuff. What if those GMO seeds end up in there? I mean, it's not like we can control where seeds go. Winds blow seeds around. It's supposed to happen. That's part of how seeds get places. So, there's a lot of concern about contamination of GMO and non-GMO and even if that's not inherently dangerous, it is viewed as dangerous by some in the public, and it could hurt your sales. And there are certain countries that have specific restrictions on importing GMO food. So if you accidentally throw some GMO seeds in with your non-GMO, maybe you can't export anything to Europe after that.

Justin: Right.

Sydnee: So, they also, Monsanto also produced some pretty unfriendly stuff in the past. Like Agent Orange.

Justin: Not great.

Sydnee: No. So, I think all of this gets tied up in the view of genetic modification technology in general, because if you feel negatively towards Monsanto, and Monsanto is an agrotech company that specializes in GMO stuff, you start to feel very negatively towards GMO products, and suspicious of what they're doing.

Justin: Right.

Sydnee: Even if maybe the two aren't intrinsically related. Does that make sense?

Justin: Sure.

Sydnee: So, I think that's a lot of where the negative side of it comes from. And I think you can absolutely be against Monsanto and their business practices, you would not be alone. In 2013 there was a worldwide march against Monsanto, the company. So, you know, I think it's totally fair to criticize, and many would, the way that they do business. But I think it's important to separate the GMO technology and look at it for what it is, from Monsanto.

And in order to do that, we have to get to the point that GMO, so far, has not proven to be inherently dangerous. Like I said, that doesn't mean that you can't ask questions and wonder if there are risks to them, but GMO products are subject to rigorous safety testing. The stuff that has been caught that has been perceived to maybe cause danger has never made it to the market. And so far, the stuff is out there, food, medicine, the like, isn't hurting anybody. We don't have any cases of people being harmed by this stuff and we don't have any scientific reason to think that it is harmful.

It's DNA. I mean, that's what we're putting in there, we're putting DNA in there and you eat DNA all the time. We are doing things like labeling food now, whether or not it's GMO. That's actually, that was passed, that law was passed in the US a couple years ago. It hasn't been implemented though. So, it's going to be, pretty soon all your food will have to be labeled to say whether it's GMO or not. I don't really know if that's helpful in the long run.

Justin: Oh I know. You don't know? Cause I know that it's not. Yeah. I mean, it's not.

Sydnee: The problem with that is that I think labeling something GMO makes it seem like—

Justin: It needs to be labeled for your safety?

Sydnee: Yes.

Justin: Yes, I think so too, Sydnee.

Sydnee: And I don't know that that's necessarily– so far, we don't have any scientific evidence that it's dangerous.

Justin: It's all so– okay. I understand there are many conflicting, different viewpoints on this. It makes me so angry.

Sydnee: I know, I know.

Justin: If you don't wanna support a corporation like Monsanto, like, I think you should have the right to do that.

Sydnee: For sure.

Justin: The frustrating thing is, for most people, when they see non-GMO, what they see is natural, healthier, better for my family. You're being marketed to.

Sydnee: Yes.

Justin: You're being a sucker and having this used against you, because you're busy and you're living your life and you don't have the time to, like Sydnee, for a week look into genetically-modified stuff to see, because you have to do a podcast about it. Like, it's just, you're being marketed to. And it's fear-mongering of the worst sort. And the thing is, the thing that kills me about it is that people who otherwise would think themselves very pro-science and very, sort of like, informed and smart about this stuff get suckered in by it. And it breaks my heart.

Sydnee: I think a good corollary is, do you know what the word "organic" literally means?

Justin: Carbon-containing.

Sydnee: Yes. But somehow, if you put "organic" on something, it is supposedly perceived as better for you. We are organic. I would not recommend eating either myself or Justin.

Justin: No.

Sydnee: But I think GMO–

Justin: You could eat me. I don't think you would regret it. I think you would be in for some nice marbling, some, not too much of that stringy gross muscle, you know? It's just a very flavorful cut of meat.

Sydnee: [laughs] The muscle is what we— well, I won't get into that.

Justin: What I'm saying is, like, it's the conflation that bothers me. I'm not gonna upset, we'll talk about it later. Do your own thing. But like, it's the conflation of, like, the farm to table movement. I think that's cool. Buying local produce. Like, I think that's cool that you wanna do that. Don't conflate it with, like, these words mean something. Like, it means something and it's important for, like, the Earth. Like, if you make this stuff— if you, a smart person, make genetically-modified stuff scary enough that people won't eat it, like, you are endangering a lot of people. Not directly, but like, in a broad scale, it's important that people know that this food is safe because it's the food that we're going to have to eat for everyone.

Sydnee: Well, and it has posed problems, because the introduction, even of what Norman Borlaug was doing, even before you get into genetic modification, just the artificial breeding and that kind of stuff, selective breeding, there was a lot of pushback to that in certain parts of Africa, when he was trying to introduce these technologies and these methods. And this is how we save lives. This saves people. This is how they don't die of starvation. And a lot of the concern over this "artificial", quote-unquote, method resulted in those techniques not being adopted right away. And every minute that you don't, you know, if you find a method to feed more people, every minute you wait to employ it, more people die of starvation.

So, it has caused problems in adopting technologies that work, and it probably has resulted in more lives being lost to starvation than would have been necessary. And there's other reasons, not just food. We keep talking about food. I wanna get back to medicine. What could GMO do? We don't know everything yet. We know we made insulin. Right? We made antithrombin. We've made the Hepatitis B vaccine. We used to get the antigen that provokes the immune response that makes you immune to Hepatitis B when you get the shot, you can inject it with something that makes your immune system make antibodies, right? We used to get that from people who have Hepatitis B's blood. Now, if that doesn't seem risky to you…

Justin: It does.

Sydnee: Right? So, don't we think it's better that now we can artificially create that antigen using recombinant DNA? It's called the recombinant Hepatitis B vaccine. It is a GMO vaccine. But, it protects you against Hepatitis B. And I think even just hearing that on the surface, without understanding all the science, doesn't that sound safer than getting it from the blood of an infected individual? From anybody's blood, not just people with Hepatitis B. I mean, taking somebody else's blood unnecessarily and putting it into yourself. You know? Factor VIII for hemophiliacs, we have made. For people with hemophilia, sorry, we have made that using GMO technology. And the clot buster, if you've ever heard of that, for strokes, tPA, we made that. So there's stuff we've already done with GMO. On the

vaccine front, recombinant DNA is probably the future of that. There are all kinds of things we're working on, like the Zika vaccine.

Justin: Yeah.

Sydnee: That's using GMO technology. Do you remember ZMapp? The experimental treatment that was used for the Ebola outbreak?

Justin: Yeah.

Sydnee: That was made using GMO tobacco plants that created a drug.

Justin: Oh tobacco, what can't you do?

Sydnee: They're currently working on an oral Hepatitis B vaccine. So, the shot that we get for Hepatitis B in this country, it has to be stored in a refrigerator. So, the cold supply chain that's necessary to take a vaccine like the Hepatitis B vaccine and send it all over the world, it's hard in some parts of the developing world, it's hard to get that vaccine to the people who need it. So something like an oral vaccine that didn't have to be kept refrigerated, and then you don't have the medical personnel who need, you know, to give the injection and you don't need sterile needles and all that stuff that goes with an injection, could be life saving. Right now, we're doing that using GMO corn. Kinda the same idea with the two Polio vaccines.

Justin: Where there was one that was, like, alive and one that was killed, right?

Sydnee: And one that was a shot and one that was oral. The oral one has spread all over the world, because it's easier to get that oral vaccine to parts of the developing world where finding the medical personnel, the sterile needles, the refrigerator, all that can be cumbersome. An oral vaccine is a lot easier. So, they're working on a Hepatitis B vaccine, an oral vaccine. That would be amazing. We could get the vaccine to places we haven't been able to effectively penetrate before. There's even a project working on malaria-resistant mosquitoes.

Justin: Cool.

Sydnee: Genetically engineer mosquitoes that can't get malaria. And then if the mosquito can't get malaria, it can't give you malaria.

Justin: And that's great for the mosquitoes too, I bet they'll be so stoked.

Sydnee: [laughs] Obviously that's not anything that's happening now, that's kind of a theoretical, let's see if we can make this happen, you know, let's do some experiments. But, there were 216 million cases of malaria in 2016. There were 445,000 deaths from malaria in 2016. What if we could stop spreading

malaria through mosquitoes? Imagine that, imagine the worldwide impact if we could do that. And GMO technologies are how we're figuring that out. They're also using gene therapy, which could be the key to cancer treatment. Introduce healthy DNA into cancer cells, into your cells to target the cancer cells better. Maybe we don't have to use more dangerous treatments like chemotherapy because of gene therapy instead.

All kinds of inborn genetic disorders or metabolic disorders, maybe gene therapy could be the key to that. This is all using recombinant DNA. This is all GMO technology. That's what it is. Let alone, in the developing world, 840 million people are chronically undernourished, and they survive on less than 8000 calories a day. We need more food. There's going to be more people. I mean, unless you're hoping for something horrible to happen, there's gonna be more people and we gotta feed them.

Justin: And listen, I get it. I get it, it's been a rough couple years. But, like, that's not the answer. Come on, we can do better than that. [laughs]

Sydnee: We're working on something, golden rice, which produces vitamin A.

Justin: Sounds delicious.

Sydnee: [laughs] It could— because vitamin A deficiency, it's responsible for 2 million children dying a year. Vitamin A deficiency. Just getting them vitamin A. And golden rice, which is enriched with vitamin A, has been thought to be one solution to that. It's a GMO product. It's still in testing and there's been a ton of resistance to it because of fear of GMO technologies and what these could do, what these seeds could do if introduced into other populations, and maybe there are better ways to give vitamin A, and all these other arguments.

Justin: [sighs]

Sydnee: But the point is, at the end of all this, the potential of GMO technology, if used appropriately with the right safety testing and guidelines and rigorous concern for what could go wrong, looking for that, stopping any experiment that isn't working and all the things that we already do in science, all the guidelines that are already in place, using that, GMO technology could change the world. It already has and it can continue to do so. It can save lives through medical applications. There's a bacteria that might eat plastic. That was just in the news the other day. Through recombinant DNA, they found a way to make a bacteria that helps break down plastics. What if we could break down all the plastics that are just floating around in our oceans right now?

Justin: But what about after it's full? It ate all the plastic in the ocean, now it's coming for our plastic.

Sydnee: [laughs]

Justin: And I love some of my plastic. It's eaten my Xbox Sydnee, oh no! Oh no, the bacteria's done ate my Xbox right up.

Sydnee: I can see the fear for an Ice-nine type situation with that. I can see that, I understand. But that's why, as with all science that's new and we're gonna apply to humans, and to the environment, we take our time. We do things with thoughtful, you know, concern and purpose. We use proper safety standards and guidelines. We don't rush anything. And honestly, in Norman Borlaug's view, the more publically-funded this research is, the more we work as a society of humans to do it and not necessarily as a corporation who has money in the game, the better our results are gonna be.

Justin: I don't mean to get worked up about this. I realise I got a little frustrated. It's, the only thing I would say is, if you hear someone talking about GMO stuff, just push them on it. Just say, like, "And what's the problem with that?" until you can get to the nut of the thing. If you wanna make a choice, if it's, like, about we should have better labeling for food, you should have the right as a person to know where your food comes from.

Sydnee: Sure.

Justin: I don't disagree with that.

Sydnee: Absolutely.

Justin: Like, I think you should absolutely have that. And I understand that, like, for some people GMO is like a convenient shorthand. I would say that, like, if that is your standard for things that you will not support in this world, you are probably putting yourself in for some long days of research. Some people are down to do that, and I completely get it. Don't, like, lump this incredible technology in with the garbage that the corporations have done when we need it to feed and save people and give people medicine. It's just… [sighs]

Sydnee: I think that's it. That's why I really don't inherently have a problem with the labeling of the food. It won't change what I do. I eat GMO food, I will continue to eat GMO food, I'm not worried about it.

Justin: I love it.

Sydnee: I got the Hepatitis B vaccine. Our daughter was born two months ago, she got a Hepatitis B vaccine when she was born and she got her second booster yesterday. I will continue to employ recombinant DNA in my life and in my family's life. I don't have a problem with it, because science tells me it's safe so far. And honestly, we do riskier things than consume DNA. I drink alcohol

sometimes. Alcohol is known to be riskier than any of these substances we're talking about. If you ride in a car, you're probably putting yourself at more risk than you are by eating GMO corn. That being said, if you don't wanna do that, fine. That's totally your prerogative. Just know why you're doing it, and don't operate based on fear of science. Operate based on a completely informed opinion that you still don't wanna eat GMO food, fine, absolutely. That's your right and you should be able to do that. But, I think that this kind of amorphous fear of anything that sounds artificial is not helpful and in this case could cost lives.

Justin: Thank you so much for listening to our podcast. We hope you've found yourself entertained and edified, which is what we strive for every week.

Sydnee: I'm ready for the emails.

Justin: But don't send them!

Sydnee: [laughs]

Justin: Honestly, like, don't send them. Who knows. Unless you want to, I don't know. It's your right.

Sydnee: I mean, you can, it's fine.

Justin: You can, it's fine.

Sydnee: But we did the fluoride one, it's fine, I got those emails.

Justin: If you're nasty about it though on Twitter, you're gonna get blocked.

Sydnee: Yeah, that's true.

Justin: Just be… tell you what, put as much work as Sydnee put into researching it before you respond back to her, how's that for a gold standard?

Sydnee: [laughs]

Justin: Thank you so much for listening to this show. I don't mean to be adversarial right at the end, I know we're talking to a very small percentage of our listenership that wants to get spicy, and for the great number of you, thank you for your continuing support and kindness.

Sydnee: Yeah. My hope is that for a lot of people, you've heard a lot about GMO but you haven't had the time to do all the research for yourself, or you have done research and you found what I found, which is a lot of different opinions based on their own interests. So hopefully I have helped to elucidate a little bit about what GMO means and what it does. That's my hope.

Justin: I wanted to say a quick thank you to some folks that sent some stuff to our PO box. Topper sent a delightful book called Princess Ninja. You can find that on Amazon, that Topper wrote, and it is great.

Sydnee: Yeah, I've read it to Charlie, like, every night.

Justin: Virginia and Erica and Alice sent us a variety of hard-crafted things that are beautiful. We got a lovely quilt from feliciagutierrez.com. I mean, that's Felicia's website. Felicia's also a person. And we got dice bags and recipes from Rebecca and Emily and a book from Carey. So thank you to everybody for those gifts, that's very kind of you.

And thanks to Maximum Fun network. We had a great drive. Thank you for your support, by the way, if you donated to our show. We met our goal for Max Fun and it was a great drive, and we appreciate you being patient and listening to our promos and for your continued support. And thanks to The Taxpayers for letting us use their song "Medicines" as the intro and outro of our program. And thank you to you for listening. We'll be back next week with another episode of Sawbones, but until then, my name is Justin McElroy.

Sydnee: I'm Sydnee McElroy.

Justin: And as always, don't drill a hole in your head.

[theme music plays]

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