# “What The Tofurkey Is Going On With Fake Meat?” Transcript

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**Justine Paradis:** This is outside in a show about the natural world and how we use it. I'm Justine Paradise

**Taylor Quimby:** And I'm Taylor Quimby.

**Justine Paradis:** Taylor, can I tell you about my top non-meat burger experience?

**Taylor Quimby:** Yeah, yeah, I love a good non-meat burger.

**Justine Paradis:** Does everyone have this?

**Taylor Quimby:** This is truly a constant topic of conversation for me now.

**Justine Paradis:** Well, you've been a vegetarian. How long have you been a vegetarian?

**Taylor Quimby:** Oh, few years, ever. Ever since our episode, The Meat Matrix, which people can listen to and find out how that went.

**Justine Paradis:** Shout out to the Meat Matrix. Yeah, I've essentially been a vegetarian. I eat fish, so I guess technically pescatarian for a long time. But I'm going to say that the landscape of fake meat has changed recently.

**Taylor Quimby:** Oh my god, totally.

**Justine Paradis:** I wouldn't even call them veggie burgers anymore. I think that they're in a new category. Well, so I decided to test this assertion. Last fall, my in-laws were visiting and my husband and I were making dinner and we decided, Let's grill out, let's make burgers. And we recently tried impossible burgers, which we were like. These are basically like me. This is just like a burger. But because I've been a vegetarian for so long, I'm like, Well, can I really say that? So my father in law eats a lot of meat. I don't think he might be sharing that he eats meat. I think basically daily. Yeah. And so we're like, OK. Can he tell the difference? So we're just we're not going to tell them that these are impossible burgers. We're just going to pretend that they're regular beef. So we serve them, we're eating outside. It's beautiful, like October Day, and we're like watching him really carefully. You know, like the vibe is a little strange, probably at the dinner table, you know, experimenting on family members, which is always like a great basis for relationships.

**Taylor Quimby:** That's how you form bonds as far as I'm concerned.

**Justine Paradis:** So he and he's he's look into it and like, we we even get him guessing. Like, Where do you think the beef was raised? Eventually catches on and he we could resist telling him, and he was really good natured about it. I would say that the experiment worked like he thought it was real meat. So we are officially in a new era of the fake meat burger. Before this point, like, I guess, I was about to say no shade to veggie burgers of the past, but I guess I like very much shade like I would just I would rather grill vegetables than than try to fake it. But part of me does wonder, like, what are we doing? Like, why are we? Why are we really trying to go so far to do this, to replicate the flavor of meat? Why is that so important?

**Taylor Quimby:** But but really, it was a question because the mimics were bad. But these these things, it's like I can to mix metaphor, you know, have my cake and eat it too. I can be a vegetarian who who gets to eat a burger. And so I don't I don't know exactly what it is that we're doing, but it feels like a question that you have to ask. The closer you get to recreating the real thing.

**Justine Paradis:** So these themes are, of course, the subject of today's episode. We're featuring a podcast that if you haven't already heard it, we think that you'll love. It's called gastropods.

**Taylor Quimby:** Gastropods is about the science and history of food, but really, it's about all the weird, wonderful things that you never knew about what you eat every day. I've been listening for a few years, and I love how comprehensive they are. They tackle a subject and they tell you from soup to nuts. So much about it. And you know, they've been around for a long time. So whatever you, you know, really almost any subject related to food, they have probably done an episode or two On that subject.

**Justine Paradis:** Like, for example, they've done topics like whether New York City bagels are better specifically because of the water or like what scientists are discovering about the link between diet and Alzheimer's.

**Taylor Quimby:** And the one we are playing today is about whether plant and fungus based fake meats really are better than the real thing. Like, are they better in terms of flavor? Are they better in terms of sustainability? And we're going to learn a lot about the science of how they're actually made, which is really, really weird and interesting.

**Justine Paradis:** Yeah. And actually the brand we mentioned impossible burgers, they end up going into the lab where those are made.

**Taylor Quimby:** Yeah. Super fascinating.

**Justine Paradis:** So all that and more is coming up after a quick break.

**[BREAK]**

**Ayman Ismail:** I actually can't wait to try it, right? This is the weird part I'm a Muslim, I never had pork. I never had like pork barbecue, but I love watching like pork barbecue shows on TV. You know, there's so many different like barbecue challenges on Netflix or Hulu, and I love them. I can't get enough

**Cynthia Graber:** What Ayman is super excited to try. What he's never had in his life is, yes, pork, but not the real thing. It's pork made from plants.

**Nicola Twilley:** Ayman Ismail is just one of our guests this episode as we figure out the science and history of plant based meat because we are gastropods, the podcast that looks at food through the lens of science and history.

**Cynthia Graber:** I'm Nicola Twilley and I'm Cynthia Graber. And this episode we're going into the labs and test kitchens where the meat analogs of the future are now being invented.

**Nicola Twilley:** We have so many questions starting with will all these impossible burgers and fungus based chicken cutlets ever really replace meat?

**Cynthia Graber:** Are they better than meat or are they better for the environment? Do they have a smaller climate change footprint? Are they better for you?

**Nicola Twilley:** Equally important, to be honest, do they taste good? Do they actually taste like the real thing? And if so, how? What magical science can turn a plant into a bleeding burger and

**Cynthia Graber:** Will plant based pork live up to Ayman’s dreams?

**Nicola Twilley:** This episode is supported by the Sloan Foundation for the Public Understanding of Science, Technology and Economics, and by the Burroughs Welcome Fund for our coverage of Biomedical Research. Gastropods is part of the Vox Media Podcast Network in partnership with Eater.

**Celeste Holz-Schietinger:** So where you are right now is our R&D lab, and what we try to do here is really understand, meet at a molecular level, understand each the components that drive each sensory experience.

**Cynthia Graber:** Celeste Holt Scheidegger is the director of research at Impossible Foods. We visited Celeste at the Impossible Labs in Redwood City in California, and because it's still a pandemic, she obviously was masked.

**Nicola Twilley:** We masked up too, and we put on gowns and goggles, and then Celeste showed us a room that basically just looked like a science lab. I mean, it was a science lab full of weird looking machines and test tubes and beakers.

**Celeste Holz-Schietinger:** So all around us are the analytical instruments to be able to ask molecularly what is in meat and be able to identify that.

**Nicola Twilley:** Impossible Foods was founded a decade ago by a Stanford University professor called Pat Brown. His research was focused on genes and cancer cells, but he'd been a vegetarian since the 1970s, and he was really bothered by how harmful to the environment industrial meat production is. Les told us

**Cynthia Graber:** This is still central to the company's mission. As you'll hear, we also met with her before the pandemic, when she wasn't masked.

**Celeste Holz-Schietinger:** So how we began was really with the vision that meat is not sustainable and it's the most destructive industry on the planet. The reason we eat it is not because of that destruction, it's because it's delicious. And so can we make meat without compromise?

**Cynthia Graber:** We've talked about this before on gastropods, but conventional meat in general and frankly, cows in particular are a source of a lot of environmental problems. Locally, they use a lot of water and cause a lot of pollution. They also contribute significantly to greenhouse gas emissions and to deforestation around the world.

**Nicola Twilley:** Scientists pretty much agree that we cannot consume as much animal based food as we do right now and stay within our planetary boundaries. We need to cut back pretty radically. And so, back in 2009, Pat Brown decided to take some time off from his regular research and try to figure out a solution to this livestock problem.

**Cynthia Graber:** Remember, Pat is a distinguished scientist, and so he went about this quite scientifically. The first thing he had to do and that he hired people like Celeste to help him do was figure out what makes meat meat.

**Celeste Holz-Schietinger:** So some of the key aspects of meat is one how delicious humans think it is. It's Craveable, it's juicy, it's fatty. There's those kind of roasted caramel notes. And one of the key aspects also is how meat changes upon cooking and how you handle it. So in the raw state will be red in color, and upon cooking, it will change to brown. It'll be soft and malleable, and as you cook it firms up and becomes chewy and juicy. And the flavor is a kind of subtle metallic flavor in upon cooking, it has that explosion of meaty characteristics. So those are some of the key aspects of meat.

**Nicola Twilley:** So that's the challenge. How do you reverse engineer all of that? To start with,

**Cynthia Graber:** Celeste showed us a machine that basically smells meat and helps her team figure out what chemicals are making all those mouthwatering flavors.

**Celeste Holz-Schietinger:** It is very complex. There are hundreds of molecules, and then of those molecules, we can actually identify which ones are overactive and what that different smell is. And there's probably around 300 that have different unique sensory experiences. None of them specifically smell like beef for a chicken. The combination is what gives you that sensory experience.

**Cynthia Graber:** The same machine can also find those odor molecules and plants. The plant might not smell like that one particular odor molecule, but it contains it. And then Celeste and her team can extract that molecule from the plants and then combine a whole bunch together to smell like meat and so taste like

**Nicola Twilley:** Meat that even once they'd figured that out, they weren't done. So much of the deliciousness of meat is also texture how it feels in your mouth.

**Celeste Holz-Schietinger:** And so again, we look at meat at the molecular level and actually ask, what are those components driving the texture? What are those specific proteins? How do they change upon cooking? They're really denatured and changing their forms. Can we measure those and then have that as a reference point and then go and screen and look at many different plant proteins and look at what their properties are?

**Cynthia Graber:** Celeste showed us a machine that can test texture, too. They can hook up a bunch of different types of things that can press down and cut through the meat in different ways

**Celeste Holz-Schietinger:** So we could have even human teeth or we have razor blades and each of those measurements, we can get different parameters and we'll screen lots of them.

**Nicola Twilley:** Yes, they really do have human teeth on this machine.

**Celeste Holz-Schietinger:** We had someone who had a dentist as a father, and so we got some teeth.

**Cynthia Graber:** Getting it all just right isn't easy. It's taken impossible years and many iterations before they release their first product. They did the first trials at Momofuku in New York in 2016. It was a burger, but it wasn't quite there yet, Celeste says. For one, it just kind of fell apart on. The grill,

**Nicola Twilley:** Which the new and improved Impossible Burger does not, and that's what's now available at supermarkets and restaurants around the country alongside ground impossible beef. And then just this autumn they debuted an impossible chicken nugget. And they're not the

**Cynthia Graber:** Only ones trying to replace beef burgers and chicken nuggets in our hearts and on our plates. Another huge one in the market is beyond meat. They're even bigger than impossible these days. They sell hamburgers and ground meat and sausages and chicken tenders.

**Nicola Twilley:** This plant based meat business is hot right now.

**Montage Speaker 1:** Meatless meats are on a meteoric rise and is projected to become a U.S. $1.5 billion industry by 2020 to fake meat.

**Montage Speaker 2:** It's turning into real profits.

**Montage Speaker 3:** The stock market debut for Beyond Meat went beyond

**Montage Speaker 4:** The hottest IPO of 2019

**Montage Speaker 5:** So far. The stock has a cult like following.

**Montage Speaker 6:** It's going to sweep over the world. All right. Our mission is very simple. It's to completely replace animals as a food

**Cynthia Graber:** Technology, but as regular listeners to gastropods will not be surprised to hear this whole fake meat business is not actually a new

**Malte Rödl:** Movement. Meat alternatives are not new at all. So in my research, I found that they have been basically a thing ever since. People have stopped to eat meat for whatever reason, and ever since they sort of thinking of not eating meat, there's ideas of having something that is like meat.

**Nicola Twilley:** This is multirole. He's a researcher in environmental communication at the Swedish University of Agricultural Sciences, and he studies the history of plant based meat replacements. He told us that these alt meats have gone through distinct phases of popularity and innovation based on why people were eating them,

**Cynthia Graber:** As we talked about in our recent tofu episode. China has a really long history of cooking up foods that are meant to be meat ish for thousands of years. They've made meat replacements out of tofu and out of wheat. Gluten, which is called Satan and Satan has a kind of meat like chewy texture.

**Nicola Twilley:** These plant based proteins weren't necessarily always used as a meat analog, but they could be a replacement for people who didn't eat meat, which was mostly for religious reasons.

**Malte Rödl:** So there are certain streams of Buddhism that reject the idea of eating animals. And so there's always this tension between if we can't eat animals, we need to have something similar, especially to wean oneself off.

**Cynthia Graber:** Soy based foods were slow to catch on in America, as we mentioned in our episode. But in the late 1800s and early 1900s, a whole bunch of new fake meat products sprouted onto the scene

**Malte Rödl:** When we see commercialization of meat replacements, meat alternatives through a person called John Harvey Kellogg. That's the brother of the person who made the Kellogg's company.

**Nicola Twilley:** This time the motivation was health. And yes, regular listeners will have already encountered our old friend, John Harvey. Mr. Cornflakes brother, he had a very unusual health philosophy, and he ended up running a sanatorium founded by Seventh Day Adventists in Michigan. Part of his whole thing was that people should eat bland, grain based foods, not fatty or sweet things or meat.

**Cynthia Graber:** So then that left a question for him. What should they serve at the sanatorium?

**Nicola Twilley:** No problemo. John Harvey invented some exciting new meat replacements.

**Malte Rödl:** So when we look at these different products than they're usually made of nuts or oats and actually nuts were not popularly eaten before this time. So nuts were actually popularized within this food movement as something legitimate and nice to eat.

**Nicola Twilley:** It's not that nobody had ever eaten nuts before, but they weren't actually popular in Anglo cuisine in the 1800s. They'd fallen out of fashion during the Renaissance and didn't come back into vogue until Kellogg gave them a boost.

**Malte Rödl:** These products then have fancy names like Nut Cream, Matos, Viola, Nut Waygo, Nut Meat or nuttin, and some of these explicitly referred to sort of what they're made of like nuts. Others refer more explicitly to what they're supposed to do. Like Nuttin is sort of is a fake to to mutton.

**Cynthia Graber:** These nut and oat concoctions actually and surprisingly became somewhat popular within a relatively limited community. But these enthusiasts brought products and nuttin to people around the world. The foods became particularly popular in England in the early 1900s because people were going through a health craze there to

**Nicola Twilley:** Naito's, and Protoss were described in their marketing materials as quote vegetable meats. In one ad, a Naito's fan said it tastes like all the naughty things, but has the advantage of being digestible and wholesome. According to Malta, people at the time would braise Protoss, mash it into a cutlet, bake it with macaroni and even subit into a jambalaya.

**Cynthia Graber:** But as popular and delicious as Nike just made these vegetable meat sound, they were really only eaten by a very niche group. At least that was true until the First World War in the UK. That's when vegetable meat found an even.

**Malte Rödl:** Bigger market meat alternatives were seen as a vital way to support the wider population, especially in the UK. This was a much larger problem than in the US.

**Nicola Twilley:** Meat was really tightly rationed, especially in the UK.

**Montage Speaker 7:** Meat, a perishable commodity long term in production, is one of the hardest food contracts to fill.

**Montage Speaker 8:** All this get along on odds and ends of meat substitutes in his sandwiches, but he doesn't grumble if he gets plenty of tea strong enough for a mouse to trot

**Nicola Twilley:** On before plant based meat substitutes it being eaten mostly by people who didn't want to eat meat for ethical, religious or health reasons. But during both World Wars, plant based protein found a new audience people who would have rather eaten real meat, but there just wasn't enough. These protein substitutes were either mixed in to make real meat stretch further or shaped into a straight up replacement like the soy sausages that were notorious in World War Two,

**Cynthia Graber:** Even though we didn't have the same rationing that the UK did. Apparently, soy sausage was a thing here, too during World War Two. It was called sausage, and the New York Times at the time suggested serving it with, quote, an appetizing tomato or parsley sauce.

**Nicola Twilley:** After the Second World War, there was a little bit of a protein panic. The World Health Organization put together a protein advisory group in the 50s, and in the late 60s they came out with a report on how to avert the coming protein crisis. There was a real fear that there wasn't going to be enough protein to feed the world, which is what led to the next wave in plant based meat innovation.

**Cynthia Graber:** This protein panic inspired the rediscovery of tofu in the U.S., which is a story we tell in our tofu episode.

**Nicola Twilley:** But this worry over protein wasn't just a hippie thing. Big AG and industry were investing in plant based proteins, too.

**Cynthia Graber:** In 1960, a big food processing company called Archer Daniels Midland invented something I used to see in health food stores called

**Malte Rödl:** Tvp textured vegetable protein spun protein. So there's lots of different names that pop up, especially in the late 50s, early 60s of technologies that are able to make this protein isolate into strings. And these strings then are supposed to resemble the actual texture of meat as opposed to merely being a nutritious thing. So what we've seen until then was more remaking the nutritious content may be making remaking the savory ness of what meat was like. And now, from the 60s onwards, we see more of a shift towards the strangeness, the texture of meat.

**Nicola Twilley:** Tvb was brown and looked like sort of freeze dried granules. It was something vegetarians put into. Tomato sauce is like a bolognaise sort of thing when I was a kid. And to be honest, I thought it was pretty grim back then.

**Malte Rödl:** Yeah, so TVP was in the beginning, I think, faced with a lot of skepticism. It's a bit weird to have these dry chunks of something that you then boil a bit hydrate and then they become a bit stringy, but don't taste like much. They always have this. They still do, I think, have this bit of an off taste.

**Cynthia Graber:** But over the next few decades, companies that were marketing meat substitutes mostly to vegetarians, they invented products that were an improvement over TVP and that you can still find today they were supposed to taste like meat. There's Boca Burgers and chicken and Morningstar farm sausage patties and lots of others.

**Nicola Twilley:** These meat replacements were not bad, but I say as someone who has tried them but who also eats meat, you wouldn't mistake them for meat. They really were for vegetarians. They weren't a replacement for a burger if you actually ate meat. But the new wave today is impossible, and beyond burgers, that's different.

**Malte Rödl:** So the new boom we're seeing in the last couple of years is related to what some academics and some industry people would describe as high moisture meat alternatives.

**Cynthia Graber:** High moisture meat alternatives sounds so delicious, but strangely, these new products are delicious. If you ignore the name,

**Nicola Twilley:** High moisture is not on the

**Cynthia Graber:** Label. No, my frozen package of ground impossible says quite proudly in bold all flavor. No cow. And it continues burgers, tacos, lasagna use like ground beef in your favorite recipes.

**Nicola Twilley:** So what is this big breakthrough? How of these companies manage to create a convincingly meaty thing from plant things coming up after this break?

**Celeste Holz-Schietinger:** First time we had a sensory panel consumer panel of us versus ground beef, it was like a 90 percent preference for the ground beef from cows. Our current product is about equal. So some people, they can tell the difference, but on a preference based on the liking base, it's very at parity and we're just early stages. The cow is not really evolving.

**Cynthia Graber:** We are what's allowed. Companies like impossible to evolve is advances in science, particularly in the field of high moisture extrusion. As Malta mentioned, this kind of extrusion is the process of taking proteins and heating them up and applying pressure to them and pushing them through a particular form. There was a lot of innovation in extrusion tech in the 80s,

**Nicola Twilley:** And those advances meant better texture in your meat. But it's not just tech improvements driving this new boom. In the past, people innovated in alt meat for religious reasons or health reasons, or out of a panic about protein. Today, the motivation is climate panic. That's what's driving this new wave.

**Cynthia Graber:** That's what motivated the folks that impossible. And Celeste says they hope to convert meat eaters with their new high moisture burgers that use new extrusion technology. She says these can satisfy any and all eaters, not just vegetarians.

**Celeste Holz-Schietinger:** So in terms of our protein toolbox. We've studied a couple hundred different proteins and characterize them. We have our potato protein, which is really a gels upon cooking and allows for that firming. And then we have soy protein,

**Cynthia Graber:** Which gets elongated and transformed in the extruder, and it becomes chewy and a little porous so it can become

**Nicola Twilley:** Juicy. Version 1.0 used a wheat based protein, which they liked, but it didn't have the same nutritional values as meat meat, so they swapped it out for the soy protein.

**Cynthia Graber:** But making impossible burgers isn't like making tofu. They aren't using soy as soy.

**Celeste Holz-Schietinger:** A lot of times we think of just different proteins. Does that mean pea and soy? But actually, soy has hundreds of different proteins, and if you fractionated them, each of them have different properties.

**Cynthia Graber:** They basically just chemically break soy apart into its different protein molecules. They figure out which ones are stretchy and which ones are chewy and so on.

**Nicola Twilley:** And with all these different protein molecules all individually isolated, they can then recombine just the ones they want in the exact ratios they

**Cynthia Graber:** Want over the development process. They also swapped out the fat that they use. At first, it was all coconut oil because that solid at room temperature like beef fat is. But they changed that to a mixture of coconut and sunflower oil to get just the right meat like nutrition profile.

**Nicola Twilley:** Ok, so there's fat, there's protein, there's the right combination of hundreds of flavor molecules, and there's additives like xanthan gum and methyl cellulose holding it all together. But the real star of the show, at

**Celeste Holz-Schietinger:** Least a spoon. I think it's important that you at least taste the heme.

**Cynthia Graber:** So let's check out a small mason jar of a deep burgundy colored liquid. It looked pretty much like it was full of blood.

**Celeste Holz-Schietinger:** Basically, dip your spoon in. Don't really need. Take much. Cheers. Cheers.

**Cynthia Graber:** Salty and metallic. It's actually surprisingly much better than I was prepared for. Yeah, I don't mind if it leaves a pretty bad aftertaste in your mouth, though.

**Nicola Twilley:** More metallic on the aftertaste, I think. I don't know

**Cynthia Graber:** Why. Yeah, I have to say now it tastes a lot grosser now. It tastes like blood in my mouth.

**Celeste Holz-Schietinger:** Yeah, I'll

**Nicola Twilley:** Just get it. After I had gum surgery, this is what my mouth tasted like. Celeste told us that this Heem stuff we were sipping this was Impossible's key breakthrough, and it's where she's devoted most of her efforts. It all started because they realized that one important element of meat flavor is something called a heme protein

**Cynthia Graber:** Heme, and the iron and heme is what makes blood bright red and the molecule transports oxygen and helps us breathe. And actually, it's key to all plant

**Celeste Holz-Schietinger:** Life, too. So we discovered that that was essential and that actually, upon cooking reacts with simple nutrients, amino acids, the building blocks to protein, sugars and vitamins, and that creates that explosion of flavor. So without the heme, you have a kind of just subtle, savory flavor, bit more bland and characteristics, and you don't have those essential meaty, beefy roasted notes.

**Cynthia Graber:** So he makes animals taste meaty. But all forms of life have heme. So Celeste and our colleagues had to find a good plant source.

**Celeste Holz-Schietinger:** Our very first projects was actually pulling out root nodules because that's where it was in a soybean and extracting that out. We quickly learned that was not efficient and actually releases lots of carbon in that process. So is there a more efficient way to do that? So what we're using is yeast.

**Nicola Twilley:** These yeast are genetically engineered to make the heme in vast

**Celeste Holz-Schietinger:** Vats, so they start white. And then when they start producing the heme, they turn bright red in color.

**Cynthia Graber:** These vats of heme producing yeast have caused him possible to get a little bit of flack. They're the only ones who use heme, and some consumers have been turned off by the fact that impossible uses a genetically modified yeast to make that heme. It's true that the yeasts have been modified, but this is super common. Most cheeses, even the really high end ones, they're made with enzymes that are produced by genetically modified yeasts. A lot of vitamins are made by GM yeasts. Medicines are too. And anyway, you're not even eating the yeast, you're eating the heme it makes.

**Nicola Twilley:** The version of heme that the yeasts produce ends up working exactly like the meat version of heme. It reacts with all the other carbohydrates and proteins and fats in the burger to create those meaty flavors. And it changes color the same way meat does, too, from red and bloody to well-done and browned impossible.

**Cynthia Graber:** And a lot of their competitors took their first stab at replacing meat by making a perfect hamburger. Because Americans eat a lot of hamburgers, which

**Nicola Twilley:** Is why it smells like a burger joint when you walk into the impossible test kitchen.

**Celeste Holz-Schietinger:** Incredible how quickly it gets your saliva like your juices flowing to smell meat

**Nicola Twilley:** In the kitchen, they have equipment for every different way. You could cook meat so they can see how their impossible version stacks up. They have steam ovens and skillets and backyard grills.

**Cynthia Graber:** They'd made us some burger sliders on a mini pretzel bun. Those were delicious, but they particularly wanted to show off a new product. They were just getting ready to introduce. It smells like pork.

**Nicola Twilley:** It's amazing. This is Impossible's brand new product right now. It's only available in Starbucks, a Momofuku, in New York and in Hong Kong, although it's rolling out more widely soon.

**Cynthia Graber:** Hamburger and ground beef was first. Then for pork, they had to tweak the heme and also the texture proteins. They got rid of the potato for the pork, so it could be a little bouncier, and they tweaked the fat content. Basically a lot of

**Nicola Twilley:** Tweaking in the test kitchen. One of the chefs, Nathan, had encased some seasoned impossible pork in pastry like a sausage roll. He gave us each one served with a spicy tomato sauce, and we dug in.

**Cynthia Graber:** So I don't have as much experience with the pork sausage rolls you do. It's very tasty. How would you say it's different?

**Nicola Twilley:** I would say right now the texture is not.

**Nicola Twilley:** It's a little softer than pork

**Nicola Twilley:** Still and a little

**Nicola Twilley:** More. I don't want to say much like because that sounds bad, but it's a little softer than than actual pork.

**Nicola Twilley:** The flavor when is is perfect.

**Cynthia Graber:** The flavor is amazing. The flavor

**Nicola Twilley:** Is perfect. The texture is very close, but not quite.

**Cynthia Graber:** As I mentioned, I don't have a lot of experience with sausage rolls, and a big reason for that is that I'm Jewish and I grew up keeping kosher at home and I never ate much of pork at all growing up, which is pretty common for Jews and Muslims.

**Ayman Ismail:** No pork, ever. Unknowingly, I may have unknowingly had it. You know, I grew up in America, grew up in the East Coast, you know, I've had pizza that had like pepperoni on it, that I like peeled off. And if I like, missed a piece, maybe I don't know, but I'm going to say, No, this

**Nicola Twilley:** Is Ayman Ismael again. He's a staff writer at Slate. He's a Muslim and like. He says he has never knowingly consumed pork.

**Ayman Ismail:** It's so taboo more than anything else, you know, you could meet a Muslim who will drink and have sex before marriage and break a lot of the rules. But pork is the one thing that I think so many Muslims, no matter where you go in the world, would be off the table, off the menu, out of their minds.

**Cynthia Graber:** We talked about this in our pig episode. Both Muslims and Jews have a lot of laws that we follow, but not eating pork for many historical reasons has become one of the most important laws of all. If you want to hear more about it, do listen to the whole hog. But basically eating pig is super taboo.

**Nicola Twilley:** But what about impossible pork? Is that taboo?

**Cynthia Graber:** This is a tough question to answer. Jewish perspective, frankly, for a lot of Jews. Sure, as long as there's no actual pork, no problem. But probably the biggest Orthodox group that certifies food is kosher. They've called fake bacon bits kosher. They've even certified impossible sausage as kosher. But impossible pork went weirdly to me, a step too far for them. I guess it's because bacon and sausage are ways of preparing meats like I've had duck bacon and turkey sausage, but pork is pig. And so to that Orthodox group, the word pork impossible pork made it not kosher.

**Ayman Ismail:** I'm like, I get that because of the the social weight that some of these products have just the names, you know? Pork isn't just a meat product for a lot of Muslims, it's been this this tool that was used to to shove in our faces that people hate us. You know, there's been how many different accounts where people have thrown bacon at Muslims or left it on the door handles of mosques or even left pig heads.

**Nicola Twilley:** But even though airmen can definitely understand not wanting to eat even plant based pork, he's personally pretty stoked to try the impossible version.

**Ayman Ismail:** And it almost feels like a loophole. It's like cool. Now I get to try pork without it actually being pork, so God is not got a problem with it because I'm not eating that same meat that God told us not to eat. So, you know, there are going to be people who are going to say no, like if you're eating it, it's like it. So your You says, if you are eating it, I don't know, man. I think God is very specific and Islam and then put on about, don't eat pig. And this isn't pig. It's not. It's this isn't right. And on their website, by the way, they say it's even better. So who knows?

**Cynthia Graber:** Who knows? Ayman wrote about his excitement and the debate within the Muslim community for Slate, and as a result, even though impossible pork isn't available yet in grocery stores. When we talked to him, he told us the company was sending over a package for him to try at home with a Jewish friend of his.

**Nicola Twilley:** And if you listen through the credits, we actually checked in with Arman to see what he thought of this very exciting, first pork like experience.

**Cynthia Graber:** So so far, all these new products we've been talking about are made from plants. But during the protein panic of the 60s, people started looking at all sorts of ways to create new forms of edible protein. They were looking at making it from algae or from fungi or from bacteria, basically single cell creatures,

**Montage Speaker 5:** Some bacteria, some single celled organisms that feed on some matter. And then in this process, they obviously grow. They they procreate and they become more biomass. And the idea behind single cell proteins is that this biomass becomes edible.

**Nicola Twilley:** Sounds delicious, right? Who doesn't love bacterial biomass? But actually one of the best known alt meats came out of this line of research corn? That story next. This all started with one of the UK's biggest food companies, ranked Hovis McDougall. They make very iconic British brands like Hovis and Mother's Pride Bread and Mr Kipling Cakes.

**Malte Rödl:** So what happened in this company was that they were making bread and they had a lot of byproducts from bread making and they were looking for bacteria on a fungi or something that would transform the starches that were a byproduct of their manufacturing process into biomass. And so they went to lots of different places around the UK and took soil samples. And after a couple of years, they decided that there was one fungi that they had found somewhere that grew really well on these starches.

**Cynthia Graber:** The fungi is called Fusarium Vedantam. It's closely related to a fungus that is a huge problem for wheat, and at first they thought it was, in fact, this very wheat disease. But it turns out the fungus they found was an entirely new species that nobody had ever identified before.

**Nicola Twilley:** Back at the lab, they grew this fungus in tanks, and when they harvested it, it apparently looked like uncooked pastry and had a quote very mild, almost bland wheat mushroom flavor. And best of all, it was kind of stringy.

**Cynthia Graber:** Initially, they were going to chop it up and make it into granules of alt meat, kind of like TVP. But people at the company realized it had a good texture on its own for things like fake chicken patties.

**Nicola Twilley:** Well, this makes it sound super easy. Find a novel random soil fungus. Grow it, form it into patties. Hey, presto! But it wasn't like that at all.

**Malte Rödl:** To make something to make some genuinely new food item like they did out of fungi is something really difficult that overall took them, I think, almost 10 years from the first idea in the late 60s to words sort of having a product, and then it took them another 10 years to get the approval as a food item.

**Nicola Twilley:** A 20 year overnight success story.

**Cynthia Graber:** At first, the company sold corn to supermarkets. It was used in Sainsbury's savory pies. One was a chicken style corn and mushroom puff pastry pie, and the other was a potato topped veggie and beef style corn pie.

**Nicola Twilley:** This was in the 1980s. I remember it launching for the first few years. While people got used to it, you could only buy it in ready meals. But then they launched corn cubes and ground corn in the 90s and then in the 2000s, corn finally made it stateside.

**Cynthia Graber:** Like me, we actually buy corn regularly. My partner, Tim, loves to have corn fake chicken patties as a sandwich for lunch in a patty. It works pretty well. It's a little mushy compared to chicken, but it's good.

**Nicola Twilley:** But still, corn isn't making juicy rib eyes. It can only do chopped steak bits and beyond and impossible or also stuck with ground meat for now. But that's not all of meat. Whole cuts are still a challenge.

**Celeste Holz-Schietinger:** Ground is part of the way, but we need entire muscle tissue. And so there are new challenges to be able to do that on the especially on the texture side.

**Nicola Twilley:** Basically, they haven't figured out how to make their protein strands long enough and stiff enough to mimic the fibers in a whole cut of muscle meat.

**Cynthia Graber:** Yet, but there's a company that thinks it's met.

**Tyler Huggins:** This challenge here in the near term will be coming out with a crispy cutlet and a steak product, a whole cut steak product. But then after that, I mean, really, the options are endless. We can produce things like pork products like fish jerky.

**Nicola Twilley:** This is Tyler Huggins. He's the co-founder and CEO of Meethi Foods MEAA, T.I.

**Tyler Huggins:** Mehdi is a type of meat made out of mushroom roots. Simple as that, like

**Cynthia Graber:** Pat at impossible. Tyler wants to save the environment. He started working in forestry, but then he went back to school for a Ph.D., and he decided he wanted to use fungi to try to solve major environmental problems. He realized that a big environmental problem he could try to fix was the meat one he checked out cordon.

**Tyler Huggins:** Of course, you know, honestly, I think it's one of the better alternative meats that are out there, but we just wanted to use modern approaches, more simple processing higher nutrition in order to make sort of the version 2.0, if you will.

**Nicola Twilley:** Just because this British company had figured out how to grow corn at scale doesn't mean it was easy, which is why they didn't really have any rivals in the fungal meat space till recently.

**Tyler Huggins:** It's very rare to actually grow mycelium for its biomass, and that's something, you know, there was no books written on how to do this, and we had to invent the process from the ground up.

**Cynthia Graber:** Tyler spent his PhD working on this problem and then years after his Ph.D., too, he and his co-founder had to figure out the process, of course. But then they also had to find the right microbes. So they held some auditions for quite a few of

**Tyler Huggins:** Them in thousands. You know, it was it was really a matter of setting the guardrails that we were looking for. So scalability, high yields, speed of growth, bland flavor, color, really good carbon conversion efficiency and then ultimately, nutrition and safety.

**Nicola Twilley:** The winning fungus has a super high protein content, and it's what nutritionists call a complete protein with. All the amino acids humans need, this particular fungus also doesn't make any chemicals that could be toxic. A lot of fungi make poisons in order to compete with other organisms in their environment.

**Tyler Huggins:** Our particular strain, it's the way it lived in the environment, is to grow super fast after fires. And so it didn't need to. It actually doesn't even have the capability of producing mycotoxins. That's something very sort of unique to our particular strain. And then because of that, we can keep the whole biomass. You can consume the whole biomass and it takes minimal post-processing. So essentially, we just harvest it gently for flavor it. And that's it.

**Cynthia Graber:** The fact that it grows so fast is incredibly important for how quickly they can make their alt meat.

**Tyler Huggins:** When I say fast growing, it's actually one of the fastest growing organisms on the planet. Essentially, we get like a seed, a starter. You can think of it just in like a small glass. Once we get it growing, we add it into our tank, which it looks like a beer brewing tank, literally overnight, 16 to 12 hours. The whole thing's full. It nearly doubles its biomass under about every hour to two hours, which is just extremely fast.

**Cynthia Graber:** Doubling its biomass just means literally doubling itself. The biomass is just the mass of fungi growing like a goop, Tyler told us. It looks like applesauce.

**Nicola Twilley:** Tyler wouldn't tell us what this fabulous fungus is scientific name is, but he did tell us what they call it in house.

**Tyler Huggins:** We like to call it Rosetta because another cool feature is under certain conditions. It smells like roses.

**Cynthia Graber:** The fact that Rosetta grows as a kind of stringy biomass is what makes it so useful as a meat replacement.

**Tyler Huggins:** Again, a huge advantage is we already have this physical structure already very, very similar to animal based muscle structure. So for us, we don't have to add a lot of complex ingredients like many of our competitors. And so you have these like 3D microscopic hair strands that are growing in every dimension. Then essentially, you realign those fibers into different orientations in order to mimic the different muscle structures. And that's how we're able to mimic things like steak and chicken and fish and pork, all from the same ingredient.

**Nicola Twilley:** Again, the details were secret, but Tyler says the processing is pretty minimal. It's not extruded. He doesn't have to break it down. In fact, Rosetta is alive till right at the end, even through the machination step, Tyler says.

**Cynthia Graber:** At that stage, even on its own, even not trying to make it taste like chicken or steak, it tastes pretty good.

**Tyler Huggins:** Oh, it's great. Now, when we first started, you know, some of the people that we were hiring were like, What are we doing again? Is this really good? And so I literally just pull it out of the tank. Squeeze the water out of it. Throw it in a pan with butter. And it is delicious. And it's kind of like calamari at that

**Nicola Twilley:** Point right now. Rosetta feeds on sugar and salts Tyler says they've already done a bunch of research on feeding it the starchy waste from brewing, for example, but for a simplicity's sake to start getting meat on the market as soon as possible. They're rolling with table sugar for now.

**Tyler Huggins:** You know, we have a current ranch, but we call it that's working right now, and that'll produce the meat equivalent of a cow essentially overnight. And then we're we already broke ground on what we're calling the Mega Ranch, and that will produce somewhere upwards of thirty five million pounds of product a year. But ultimately, again, that's that's not even that much drop in the bucket. So we're hoping to get our giga ranch off the ground sometime or at least started early next year, and that'll produce hundreds of millions of pounds. And these are all custom designed, based like big breweries.

**Cynthia Graber:** Media isn't on my local grocery shelf yet, but they're going to be launching their crispy chicken cutlet this year, and they sent us each two cutlets to try. Tim and I cook them up and tasted them before we got more elaborate and turned them into chicken parm. Oh, it smells like chicken.

**Tim:** Like chicken? Yeah, really uncanny.

**Cynthia Graber:** Wow.

**Cynthia Graber:** Oh my god, that's really good.

**Tim:** That's frighteningly realistic. I haven't eaten chicken in so many years, but that's like, Yeah, that's the that's the thing.

**Nicola Twilley:** Meanwhile, in Los Angeles, Jeff and I sat down for a fungus cutlet and some green salad.

**Jeff:** Well, yeah, it's funny. I mean, when you say fungus based meat instantly, there's a certain skepticism that comes into the picture, but it looks like a large breaded chicken McNugget that I would have had at public school. If you didn't tell me what it was, I would have thought it was kind of a slightly soft, very tender chicken cutlet. And I wouldn't definitely would not have guessed that it was made from fungus and it doesn't taste bad.

**Nicola Twilley:** That's pretty nice. Days like chicken nugget. Honestly, I can get behind that. So yeah, on the flavor and texture side of things, team alt meat seems to be doing pretty well, but that's not the only area for comparison beyond taste. How do these plant patties and fungus cutlets stack up to their real meat analogs? Are they really better for the environment, better for your health? The best of

**Raychel Santo:** All, yeah. I mean, some of the languages, I find it quite shocking or, you know, they're going for that wow factor. As you know, this is this is the solution for our future. This is going to solve a big portion of our climate change problem or completely overhaul the need for industrial animal farming.

**Cynthia Graber:** Rachel Sento is a researcher at Johns Hopkins, and she's one of the authors of a paper that takes a full lifecycle look at meat versus these new alternative meats on the market. She was also on our Dig for Victory episode about urban farming.

**Nicola Twilley:** Obviously, there's a lot of nuance in a comparison like this, and one thing to know is that Rachel and her colleagues used industrially raised meat as their benchmark on the health comparison because that is 99 percent of the meat consumed in America.

**Cynthia Graber:** Rachel also created kind of an average of these meat alternatives because there aren't enough studies to tease out major differences between soy or pea or fungus based meat. Yet, she says more research is needed, but there's enough out there that she can make some generalizations from

**Raychel Santo:** A nutritional perspective. Most plant based substitutes are pretty similar in terms of the amount of calories, protein and iron that they have in comparison to the meat products they're intended to substitute. They tend to include more sodium compared to unprocessed meats. You know, there might be slight differences or increases in certain types of nutrients or breakdowns of nutrient profiles. The overall implications of that for health outcomes is less clear.

**Nicola Twilley:** One thing that plant based meats would seem to have going for them is that they're based on plants. So you would think that they would have all the known health benefits of plants and none of the known health issues that come with eating red and processed meats. But Rachel said that's not necessarily the case. Take heme Impossible is so excited about how he makes their plant patty taste, but

**Raychel Santo:** It's processed in the body virtually identically as heme protein that's found in red and processed meat. And that is actually one of the ingredients that's linked to a lot of the health outcomes. The negative health outcomes associated with red and processed meat.

**Cynthia Graber:** That said, animal heme is the most bioavailable form of iron. And so this plant based animal like version might be good for people who are anemic or for pregnant women

**Nicola Twilley:** When it comes to the potato and soy parts of the patty. We know that eating those plants is good for you, but Rachel said what we don't know is whether those benefits still apply after impossible. It's broken down all these plants and process them to isolate out and recombine all the different proteins.

**Raychel Santo:** We do know that highly processed foods are ultra processed. Foods are associated with increased weight gain and obesity. And so there are there concerns that are these similar to other highly processed foods? Or is there something different about them that would make them more nutritious or potentially still beneficial, even if they are highly processed? So there's a lot to tease out there.

**Cynthia Graber:** What companies like Impossible say is they've basically matched the nutritional profile of meat. But even if the nutritional panel on the side of the box looks the same, a lot more research is needed to know if our bodies digest those nutrients the same way and how healthy these foods really are.

**Nicola Twilley:** Ok, so the health question is complicated. There's a lot we don't know at the moment. We can't say for sure that these alt meats are better, worse or the same for you as actual meat. But when it comes to the environment, that should be simpler, right?

**Raychel Santo:** Conventionally farmed beef has the highest environmental impacts on almost every metric you look at. So if that's your point of reference, almost any alternative is going to look sustainable or more sustainable.

**Cynthia Graber:** By comparison, if you compare these alt meats to other meat meats, the benefit isn't as dramatic. Basically, the greenhouse gas reduction and land and water use reduction when you eat an alt meat burger is a huge improvement over industrial beef, but it's a slightly less dramatic improvement compared to industrial

**Nicola Twilley:** Chicken for this part of the paper. Rachel and her colleagues did compare the full range of meat production systems, and their research suggests even the lowest emissions beef is still higher than the highest emissions plant based substitute. Other studies suggest that beef raised on well-managed pastures might have a smaller footprint than some plant based meats. Again, we can't say for sure right now for every specific situation, but definitely pretty much anything and everything is better than industrial beef, which just to repeat myself, accounts for 99. Percent of the vast quantities of beef that Americans are eating.

**Cynthia Graber:** One concern that's been raised is that these alt meat products are still using monocultures of soy and peas and sugar that are based in industrial agriculture like soy uses a lot of herbicides and pesticides and is generally not the greatest crop from an environmental perspective. But Rachel still says that even taking that into consideration, these products overall are an environmental improvement,

**Nicola Twilley:** And there are other benefits of plant and fungus meats that are harder to quantify, but very real. The jobs making these meat substitutes are better and safer than jobs in slaughterhouses. When you aren't dealing with live animals, then you aren't dealing with E. coli that can cause outbreaks of food poisoning and kill people or make them sick. And you aren't giving animals antibiotics and contributing to the big antibiotic resistance problem we have right now.

**Cynthia Graber:** Okay, so overall, these alternatives seem pretty clearly like an improvement over industrial meat in a lot of ways. But now, for one of our big questions, are these companies doing what they set out to do? Are they convincing meat eaters to eat less

**Raychel Santo:** Meat right now? To be honest, from the data that I've seen, it doesn't look like there has been a substantial substitution effect

**Nicola Twilley:** Happening in America. At least meat sales aren't going down, in fact, the exact opposite. Even in the past few years, while all these new alt meats have been launching, per capita meat consumption has increased every single year.

**Cynthia Graber:** Celeste told us that Impossible has done a number of surveys of their consumers, and about 90 percent of them have eaten meat in the past month. But it doesn't seem like they're necessarily replacing a meat hamburger with a plant based burger. Both alt meat and meat meat consumption is up, so maybe they're just choosing an Impossible Burger when otherwise they might have eaten a salad.

**Nicola Twilley:** That said, these alt meats are still new meat he hasn't even launched, so maybe meat eaters will end up reducing their meat meat consumption in favor of alt meat. Right now, it's too soon to tell. There's no real evidence that's happening yet, but the

**Cynthia Graber:** Growth of both markets shows that people just love meat, Malta says. That's obvious. Even just from the advertising,

**Nicola Twilley:** The very idea of a meat substitute sort of has the idea that meat is essential built into it. Meat must be super important. Otherwise, why would you need a substitute for it?

**Malte Rödl:** So what all this talk about meat alternatives in this way does is that it firstly reproduces ideas that meat eating is an essential thing in society and that we should all do it to sort of keep a happy life together. On the other hand, what this does to a vegetarian food is sort of it. It diminishes it a bit. It says this is second class food. It's not the same thing to cut up a cauliflower and roast it, but you need to make it cauliflower wing so that it becomes socially acceptable to eat them. So I think of it in some ways as as a colonization of the vegetarian space of vegetarian eating practices.

**Cynthia Graber:** But what about cauliflower cauliflower on its own, especially if you roast it? It is pretty great. So as lots of vegetarian food, but

**Raychel Santo:** We're not limited to a choice between conventional meats and plant based substitutes. There are also less processed legumes. You can eat soybeans and lentils and beans directly, and those have even clearer health benefits and environmental benefits, too. So while we focus this paper on comparing the particular meat and meat substitutes, it's important to not forget the bigger picture that you can also just eat whole legumes and you'll be you'll be healthier and be protecting the environment more with that choice as well.

**Nicola Twilley:** In fact, when Rachel and her colleagues did their analysis, eating beans and veggies worked out better for the environment than any of the old meats. And we already know they're great for your health.

**Cynthia Graber:** But also, maybe these meat substitutes don't need to be meat substitutes. Tyler at Meat thinks his company's new product can and maybe should be its own thing. The meaty fungus Rosita is super efficient at creating protein from sugars and salts even more efficient than plants, and Tyler would love us just to buy and eat Rosita.

**Tyler Huggins:** I think for now, we'll have to give customers some sort of association. So whether it's the meaty crispy cutlet, the meaty steak, so they kind of already know what experience they're going to have. I imagine we do that for a few years, but ultimately I think the goal is to be a whole new category of protein. So when you go to get your burrito or a taco or whatever it is, they ask you, you know, you want your beef, your chicken or your meaty.

**Nicola Twilley:** It's Tyler. This version of Meaty, where it's pretending to be a chicken cutlet that's just 1.0. The future is wide open.

**Tyler Huggins:** I feel like this is like when wine was first invented, it was like, Oh, this is pretty good, right? But now look at how many wines we have on the complexity and the science and the brilliance of what's created. I think we're just getting started. There's there's different types of umami and flavor and textures and, you know, being able to blend it with different things. I mean, this is just the start of something. I think when my daughter is older, we'll we'll just be blown away that we lived without this sort of, you know, type of food in our diet.

**Cynthia Graber:** I look for. Having these new protein sources as regular options alongside even meat, because, frankly, Nikki and I and Tyler all think there is a place for meat in our agricultural system, not industrial meat, and certainly not nearly as much meat as we eat today. But we don't think meat and dairy will ever totally go away. And maybe they shouldn't.

**Tyler Huggins:** You know, my my dad has a bison ranch. I grew up in cattle country, so I have a very high bar for good quality protein and more and more of an emphasis on ethically produced protein. And so that's never been my goal of trying to replace regenerative ranching and good practices. But just understanding that we're trying to feed 10 billion people, we're going to need as many sources as we can and those that are done sustainably and ultimately at a price point that is accessible to everybody is is what's most important to me,

**Nicola Twilley:** This global view, Rachel says. It's important when we think about the future protein because we're not just talking about hamburger loving Americans needing to cut back here. That's only part of the story. The more wealthy a country becomes, the more meat it typically eats.

**Raychel Santo:** There are some people that have actually argued that that's the value of the role of meat. Substitutes is really to serve as the filler for that increased demand that we know is coming from other countries seeking to increase their meat consumption for individual consumers or having growing populations. And so some people say that's what this is, is to fill that gap so we don't increase our overall impacts as much.

**Nicola Twilley:** Obviously, there is some issues with saying that as people in developing countries become wealthier, then they can have fake meat instead of real meat. In fact, it's arguably much more fair for developed nations to give up meat. But Rachel's point is that the demand is growing, and if we don't do anything about it, our appetite for meat will destroy the planet, no matter

**Cynthia Graber:** Who they're marketed to and how they're supposed to save the planet. I have to admit I do actually really like to eat these old meats. I'm not giving up lentils or cauliflower, but I kind of think there's a place for these foods to. Maybe they can also help serve as a transition to more vegetable and bean based meals, especially if we do what we should be doing and create a lot more regulations around industrial meat production.

**Nicola Twilley:** Yeah, it's great having a consumer based solution to the meat problem, but we actually need government to step up to so that the true environmental cost of meat is part of its price. But stepping off my soapbox for a minute, I agree I'm all about having more fungus in my diet, for sure. Rosita, I'm India

**Cynthia Graber:** And now for the big reveal. But first,

**Nicola Twilley:** Thanks this episode to the folks at Impossible Foods and Meaty and Tomato Rodel and Rachel Santo. We have links to their products and their publications on our website at gastropods. Thanks also to producer Sonia Swanson for all her work on this episode.

**Cynthia Graber:** And thanks to Ayman Ismael, we have a link to his Slate article. And finally, Ayman and his Jewish friend Leah made pork gyoza and pork kofta, which is usually made with lamb, and maybe Almond had built up a little too much anticipation around pork.

**Ayman Ismail:** I mean, I've heard from many people that pork is like the best meat, and now that I know that I've tasted it, I can kind of come back and say, I don't really think that's true. Have you had lamb? Like, Have you had goat? Have you had any of these like incredible things that we're like we love and we're used to making it all of our different Arabic and Jewish dishes like, I don't know, like, I think we we won't miss pork.