Glycobiology with Michelle Dookwah
Ologies Podcast
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You know that person who just cut you off on the highway? That one. That turd behind the wheel? You know malicious YouTube commenters? But also Dolly Parton? And your ex-officemate's pet chinchilla? What do all these beings have in common? They effing love carbs man. Love 'em. All of us. We are just walking, breathing, dumpsters of bread, and fruit, and starch, and saccharides. Even if you don't even eat many carbs, your cells are still composed of them and you'd be up quite a creek in their absence. Thanks, carbs.

Hey hi, it's me, it's Alie Ward. This is *Ologies*. Hi. So, in this episode, we'll talk about what a carb is, and why people are in labs studying them, and if they are wearing lab coats or not, and how Harrison Ford is involved, what kind of diet we should eat to feel less like a post-holiday marshmallow. And which diets are fads, how much sugar is bad for you, and why, you know what, it's not your fault that you would risk early death to lick brownie batter from a bowl with your fingers, and also why does any of this even matter?

Now I want to say, before we get into this episode, one thing I've gotten some tweets about recently is a closure to the Feral Audio Network. People are like, "Alie, what's happening with *Ologies*?" Heads up, nothing. *Ologies* hasn't been on Feral Audio since episode one. I left in September. So, *Ologies* continues.

So, thank you to everyone who has merch or is a patron, and to everyone who tells friends, or tweets, or subscribes, or taps the guy next to them on the subway and says, "you should listen to this." Also, thank you to everyone who leaves reviews on iTunes, which helps the podcast stay up in the charts. It's amazing. It's been in the top 50 or top 20 or top 10 ever since we started. That's crazy! Also, I read all of your reviews and I love them. Do you want to hear a few from this week? I'm gonna read you one of my favorites. I'll read you my favorite one. My favorite one this week was by the *Joy Sandwich* podcast. Which is another great podcast that I really wanna go on. They say:

> *If you want to learn all the things while feeling insignificant and humbled and like a tiny clump of atoms,* Ologies *is your jam. It's the greatest. So much learning and sillies and just the best reminder that we are here together on this pale blue dot.*

Also, Livie821 says she honestly wishes she was my best friend. "Is that possible? Because that'd be rad." I don't see why not Livie. Consider it done. We do have to get matching tattoos, which we will have to carve with steak knives. So, if you're still up for that, holler at me.

Okay, I also want to thank everyone for the patience over the holidays. Episodes were a little more sporadic. I wanted to get glycobiology up last week. I was visiting my parents in the woods and there was all this cool wood to be chopped, and I got to help fix a furnace which ruled, and there was a *Friends* marathon on, and you know what; it was just really nice. So, I took the week off. So, thank you for your patience.

Okay, so on to our guest. Loosen your belts and just unbutton the top one of your pants, no one cares, and get ready to freebase some pixie sticks, because we're diving face first into carbs with a woman who is a graduate student at the University of Georgia at the Complex Carbohydrate Research Center. Which is a thing! Please feast on the knowledge of Glycobiologist, Michelle Dookwah.

Michelle Dookwah: So, I'm Michelle Dookwah.

Aside: Now, Michelle is originally from Athens, Georgia, but she did her undergrad in Connecticut, where it is very cold. And she was checking out schools for her graduate research, and an advisor at the University of Georgia offered her a tour of this really unique research facility on her campus. She was like, "Whaaat is this?"

Michelle: So, he took me on a tour of the building and he's like, "We study complex carbohydrates, which is just a very underappreciated macromolecule."

Alie Ward: [*laughs*] It's the underdog.

Michelle: It is. What it really is... So, you know there's like four macromolecules that make up life. There's nucleic acids, lipids, proteins, and carbohydrates.

Alie: Really?

Michelle: And people give a lot of attention to the other three. Obviously, like, DNA and RNA are like super-hot. And that's totally fine. They're super important too. But what a lot of people don't realize is that literally every single cell in the human body, in the animal body, in bodies, is covered in a layer of complex carbohydrates. You have to use certain microscopes to see this really well. But essentially, if you think of a tennis ball and the yellow fuzz on the outside looks a lot like the actual outside of a cell.

Aside: These carbohydrate chains are sticking out of a part of your cell membranes called the lipid bilayer. It's called that because it is two sheets of back-to-back fats that help in controlling what comes in and out of your cells, and which other cells your cells hang out with, etc. But it's not just a smooth, glossy surface.

Michelle: We think of these nice, like organized, like fluid model of the lipid bilayer. But in the lipid vilator... [*Lipid villaaattorrr. Liipppiiiddd vvviiiilllaaatttoooorrr*]

Aside: Lipid bilayer is hard to say. It's hard to say but fun to say. When I was in biology studying bio in high school I used to get the words "lipid bilayer" stuck in my head like a song or a grocery list. Like, I'd just B-Bop around going, [*singsong*] Lipid Bilayer, Lipid Bilayer, Lipid Bilayer. It's sooo goood!

Michelle: … lipid bilayer, actually, like proteins and different types of lipids that have complex carbohydrates just jutting off of them.

Alie: What do they do?

Michelle: They're really important for cellular communication, for the most part.

Alie: Really, like what?

Michelle: For instance, two proteins that may have… or a protein that may have a carbohydrate motif on the outside is what it would be called.

Alie: That sounds so fancy. [*fancy rich voice*] I have a carbohydrate motif.

Michelle: [*laughs*] Indeed.

Alie: [*fancy rich voice*] In my guest bathroom we've opted for a carbohydrate motif.

Michelle: If it has a carbohydrate motif on the outside of it, there could be a neighboring protein that has a carbohydrate binding segment. And those would be called carbohydrate binding proteins. So, it's a way for two cells to interact with each other.

Alie: And why do they want to bind? Why do the cells want to bind?

Michelle: A lot of times it initiates other signaling in the cell.

Alie: Like what?

Aside: I am just straight up interrogating this poor woman.

Michelle: For instance, bacteria have a lot of carbohydrates on their cell surface too. This isn't just like you know a human thing, this is any cell type. And immune cells will actually bind to carbohydrates on the bacteria cell. And that's how they recognize, they're like, "Oh wait, this isn't a human carbohydrate," because bacteria express their own types of complex carbohydrates and it's like, "Wait, this isn't a human," and then they will initiate the immune response.

Alie: Really!?

Michelle: Yeah! So, it's a huge player in immunology. There's a lot of studies… At the center that I work at there's actually several immunologists studying these carbohydrate binding interactions between pathogens and the host or the human body.

Aside: So, sticking out of the lipid bilayer of cell membranes are like, party streamers, if you will, composed of all of these different sugar molecules. Like, you know those things in gas stations or oil change places that, like, whip around, those weird

windsocks that dance around? They're like that, but they're made out of sugar. And they can be chunkier too, with just a few carbohydrates each. They can be short and squat, or they can form these long chains called saccharide chains that be, like, a hundred sugars long!

So, why are all of your cells and animal cells and bacteria cells wearing these extravagant feather boas made of sugars? What is happening? What's going on? What kind of craziness is this!? Most of the time, they think, it's for signaling other cells. Probably?

Michelle: I have to admit that a lot of the field of glycobiology is figuring out what these carbohydrates do. We don't one hundred percent know for every single case.

Alie: How do you see them?

Michelle: Actually, the way I analyze them is using mass spectrometry.

Alie: Okay, so you shoot light through them and check out a rainbow?

Michelle: Not quite.

Aside: I have no idea what I'm talking about here. I got mass spectrometry very confused with spectroscopy, I think… Which involves rainbows, and light, and looks like the cover of Pink Floyd's 1973 album *Dark Side of the Moon*. Which then sent me down a path of, why did they use that image? Turns out, one of the Pink Floyd album designers saw the image of a prism in a physics textbook and was like, "Dude that's dope. Let's use it." Now remember, light splitting has nothing to do with what Michelle does. She uses mass spectros… No, spectrometry. Yes. That involves ions. I wanted a visual for mass spectrometry and the machine just looks like a big Xerox machine, or a printer that weighs, like, 500 pounds. This is how it works. Nothing to do with rainbows.

Michelle: And it shoots them into the instrument. And this instrument literally just measures the mass to how much charge sticks to it, how many little sodium bits stick to it.

Alie: And then you can identify?

Michelle: And then we can identify them based on their mass-to-charge ratio.

Alie: What was your first day like in the lab?

Michelle: Wow, my first day. So, I rotated through a lot of labs before I finally settled on one lab. And my first day I actually knew that this was the lab is going to join because I'd just done a rotation in a lab that was filled with guys, and as much as I love sports, like, aaallll they did was talk about football. It was... It drove me crazy. And I walk into this new lab…

Aside: So, on her first day, another grad student walks up and says:

Michelle: "Oh my god I love your leggings. Where did they come from?" As much as I hate admitting it, I was just like, "This is my home." I knew I needed somewhere that I could be comfortable and just talk about what I felt like talking about most days. It was great. But kind of early on in the lab there were a lot of techniques I needed to learn. I knew nothing about glycobiology. I knew nothing about mass spectrometry. So it was a pretty steep learning curve, but there are a lot of grad students in my lab and they were all very, very helpful in terms of helping me learn the techniques that I needed. But it was overwhelming for a little bit. It was kind of like, "What am I doing here?"

Alie: What kind of leggings were they?

Aside: I don't know, I had to ask. They must have been, like, legit leggings.

Michelle: Oh, they were actually just black leggings from, like, Old Navy. But she just she was just like, "Oh they don't look like the sad, thin kind that when you bend over you've got problems." She's like, "Oh they look really good," and I was like, "Cool."

Alie: So, did you have to learn how to pipette things and look at things through a microscope?

Michelle: So, pipetting and microscopy were actually things that I knew how to do. I did a lot of research in my undergrad and even some in high school. Those were skills that I was pretty good with. It's a lot of, like, analytical and chemistry techniques that I didn't really know. And then I do a lot of cell culture.

Aside: So, for Michelle's thesis project she's researching the effects of glycolipids on a disease called Salt & Pepper Syndrome, named such because it causes spots of hyper and hypo pigmentation, as well as seizures and intellectual disability. So, it's rare and it's not good. And if you're curious and want to do just some light reading, you can google this title of a paper. It's called: *A mutation in a ganglioside biosynthetic enzyme results in Salt & Pepper Syndrome, a neurocutaneous disorder with altered glycolipid and glycoprotein glycosylation*.

Michelle is just, you know, low-key working toward understanding it and finding better therapies for it. Just, you know, like a boss.

Alie: What were you like as a kid? Did you have microscopes, did you like science?

Michelle: Yeah, I was actually really, I guess, lucky, in that I was exposed to science and I really liked science at a young age. My dad is a veterinarian and he actually teaches at the UGA vet school and he would always let me come hang out in his lab with him. And so, I learned how to use a microscope at a pretty young age. I remember a science fair project one time, he let me take a bunch of agar plates, and swab bacteria on them, and grow bacteria.

Alie: What kind of stuff did you grow? Or what kind of stuff did you swab?

Michelle: Yeah, it was one of those you, like, wet the Q-tip and swab the door handle and people's hands.

Aside: Honestly, how cute would it be if your veterinarian's daughter asked to swab your hands so she could grow a culture? I would be like, "Yes, please do that, and then also please take me directly to the hospital, because I am currently in the process of dying because that was fatally adorable. You have killed me with your cuteness." Also, Michelle, thank you for growing up to cure diseases. You rule.

Alie: Do you have any favorite movies that involve glycobiology? Are there any movies?

Michelle: There is a movie about glycobiology! Yes. It's called *Extraordinary Measures*. It came out in 2010, I believe. I have to admit I haven't seen it. It's not on any of the streaming services and I really can't find a copy to watch.

Aside: Oh, have you not heard of this movie? That makes sense. On Rotten Tomatoes, it scored a - are you ready for this? - 28% fresh rating. Meaning that 72% of critics would have lobbed decayed food at the screen if they had the chance, despite a whole bunch of movie stars being in it. Ouch.

Michelle: What's crazy is, like, it has Harrison Ford and Brendan Fraser.

Alie: And it's about glycobiology?

Michelle: And it's about glycobiology! It's about this like a businessman, I believe, whose two kids are diagnosed with a rare disorder, and it turns out it is what's called a congenital disorder of glycosylation. Any disorder that's caused by problems in making glycoproteins or glycolipids is just called a congenital disorder of glycosylation. So, it just means a gene involved in glycobiology like glycosylation has been messed up quite a bit.

Alie: Glycosylation sounds… Like, I want to drop an album called, *Glycosylation*.

Michelle: I know! It's a cool word. Yeah, I agree.

Aside: So, in the movie, Brendan Fraser and Kerri Russel's two kids have a disease called Pompeii's Disease. Which is a real disease. This is based on a real family. He's a pharmaceutical executive and he wants to find out more about it and he wants to find a treatment. And so he drops everything, and he and this one scientist played by Harrison Ford, go on a mad race to study this disorder and try to find a cure for it. In the trailer, which is like 3 minutes long, someone says, at different parts, "Are you crazy?" And then later, "Are you insane?" So, they were like, "Ya know what? Once isn't enough. Let's put it in there again."

Michelle: And yeah, there's this one phrase Harrison Ford says - this is just what I've heard from other people - he's like, "Don't you know about glycobiology?" It's like, the answer to that for most people is no. No, I don't know about glycobiology.

Alie: Like a very much negative no.

Michelle: The majority of the population unfortunately. But it is really, really important.

Aside: Sometimes what makes a good article doesn't always make a good movie. That's okay. You try things. You try it.

Michelle: So, we maybe need to get that movie out there more. I don't know. Maybe Netflix should stream it now.

Alie: I think you should put out a call. If anyone has a copy of this they need to reach out to you.

Michelle: That would be awesome.

Alie: I mean, come on.

Aside: I wanted to see just how elusive this film is and it turns out you can totally rent and stream it for like $4 on Amazon, where it enjoys a healthy 4.5 stars. It's undetermined if glycobiologists are the only ones watching the movie.

Alie: When you tell people you're a glycobiologist, what's the first question they usually ask you?

Michelle: What is glycobiology? Which I try to give just a succinct, 'it's the study of complex carbohydrates' but not like the ones… I don't study bread. A lot of people are like, "Oh so should I eat white bread?" I don't know. Sure, if you like it.

Aside: Okay, number one, live your life. Number two, if your life confuses you, as mine does, there's a reason. Now, for years people have been saying that white bread and refined flours are the foodstuffs of Satan because there's not enough fiber in them to slow down digestion, and you get too much sugar into your blood at once, thus taxing your pancreas and leading to Type 2 Diabetes. But a study came out in June 2017 that said, "Researchers found no overall differences in glycemic control when people ate white bread compared to whole meal sourdough bread." They apparently found that some people responded better to white bread, others responded better to whole meal sourdough bread, and the response could be predicted by the types of bacteria living in the gut.

Now, hold up, so this was only a week-long study with only 20 volunteers. This is essentially like if at a family reunion, you were like, "Hey, half of you guys eat white

bread, half of you eat wheat, tell me how you feel." Also, two of the researchers involved in this study work for a company that, "Offers to balance your blood sugar with personalized nutrition, with dietary advice based on the results of stool tests." So, a couple of the researchers are directly making money off of finding out if gut bacteria helps balance your blood sugar.

So, if you're confused, that's because sometimes scientific studies can be stretched and interpreted by like, *Us Weekly* to mean what you want to hear, which is, 'eat whatever you want.' Okay, back to how Michelle handles glycobiology cocktail party talk.

Michelle: And then I just always have to do a quick answer of that, like, "It's on all of your cells and it's really important for cell signaling and your immune system."

Alie: Does your business card say glycobiologist?

Michelle: No. [*chuckles*]

Alie: It should. Now, you met your husband through glycobiology?

Michelle: No, actually. So, we both study glycobiology…. My husband and I met in high school in Athens.

Alie: Awwwww!

Michelle: Yeah, we started dating our senior year of high school and then we both went away for college. I was at Yale in Connecticut.

Aside: Meanwhile, her high school sweetheart and future huzzzband was at Northeastern in Boston. About two hours away from each other. Did that suck?

Michelle: It was manageable.

Aside: In the end, when it came to picking a grad school, they both liked Georgia and they both happened to pick glycobiology. Although his main focus isn't on animal cell walls, it's researching and generating better plants for biofuels. Can you imagine anything more trendy than a car that runs on avocado? It would be amazing.

Alie: Do you guys talk about glycobiology a lot?

Michelle: We do. We talk through each other's problems a lot. I have to admit, I don't know tons about plants, and he doesn't know tons about, like, neurological disorders.

Aside: Do she and her husband ever, [*gasp*] cut carbs? GAAASP! Pearl clutch. Smelling salts.

Michelle: So, we never do the low-carb high-fat kind of set up like the keto diet.

Alie: The Atkins.

Michelle: Yeah. I'm not a huge fan of that.

Aside: You may have heard a lot about the keto diet lately, as this little family, little family of billionaires, called the Kardashians and also this lady named, uh, Beyoncé? And all of these tech CEO 'biohackers' have been swearing by it, especially in the last few months. Is it new? No. It was developed in the 1920s as a remedy for epilepsy and it's still used today to control seizures.

So, what is the ketogenic diet, how is it different from low carb and Atkins, and what is the deal? What is the deal!? Okay, keto is very low carb, less than 50 grams of carbs a day, sometimes lower than 20 grams of carbs a day. Not just sugars but carbs in general. Your body stores carbohydrates in the form of glycogen for fuel. And we take that and squirrel it away in the liver and your muscle tissue. And when you cut carbs and don't replace those back-up stores, you run out of glycogen, and your body goes into ketosis. That is when you are out of glycogens, so you break down fats into fatty acids and ketone bodies that are used for fuel for the body and for the brain. So, you kinda switch over to a different fuel system.

Now, a few things: each gram of glycogen in your body's stores is bound to, some experts say, 3 to 4 grams of water. So, when you use up those stores, you lose a bit of water weight super fast. Which is partly why, if you've ever been on a low-carb diet for, like, I don't know, a television job, and once it's wrapped, you've like, I don't know, gone to Little Italy and eaten a trough of gnocchi, two baskets of bread, and a tiramisu, alone, such that the waiter seems to want to ask if you just gotten out of prison, the next day or so you will be, like, ten pounds heavier on a scale and your denim skirt won't zip, in 2003. Just saying.

Each glycogen shows up to your muscle party with an entourage of like 3 or 4 water molecules. When you get rid of the glycogen you get rid of some water too. Low carb diets are helpful for quickly losing water weight, for sure. From there, eating for keto is about 65% fat, 35% protein, and about 5% carbs. It is said to keep your body burning your fat stores and also promoting something called 'autophagy', which is Greek for 'eating yourself'. Your body just casually eating itself like a hungry goat, going around scanning the cupboards, gobbling up screwed up cells and weird bits of scar tissue and extra cancer mess-ups and recycling the parts.

That's another reason people like the keto diet, is you burn fat really quickly when you switch to fat-burning ketosis and possibly it can be healthier in other ways. Now there's some controversy about autophagy and its role in cancer. On one hand, it can grab tumors and nip them in the bud, but in later stages, it could promote tumors spreading. I do not have the answers for you here, but Dr. Yoshinori Ohsumi is on the case, he just won the Nobel Prize in 2016 for his work on autophagy. Google that.

So, you thought you were just gonna learn about carbohydrates and how to make your pants button and now you have all kinds of dirt on glycogen, and fatty acids, and cancer, and rare diseases, and how much gnocchi I can eat in a sitting. Which is a lot. By the way, if you're like, "Where is the Atkins diet in all this? The low carb one where I just eat bacon sandwiches with slabs of cheese as the bread and then I eat a mayonnaise milkshake?" That promotes ketosis too, but it's got some stages in terms of carbohydrate levels, and the keto diet is a little more exact and less like, "Go forth and drink queso, my children." I will say, I have friends on the keto diet who absolutely love it, and say they have never felt better, and have shed a lot of weight. So, your mileage might vary. Do your research ahead of time. Side note, if you're trying to get healthier in the new year, and lose weight, and opt for low carbs, it is best to do it with whole foods and cut out the diet drinks and diet foods, which can mess with your insulin levels and make you hungrier also.

Now, if you see sugar alcohols on a label, the best way to consume that is by building a large bonfire, throwing the item onto the bonfire, and then running very far in the other direction. Unless you're okay passing undigestible molecules into your large intestine to ferment and cause gastrointestinal distress on parallel with drinking from a puddle in Calcutta, which is what some sugar free diet foods that have sugar free alcohols like mannitol can do. So, google "sugar free gummy bears + amazon reviews," settle in for what sounds like war journalism from the front lines of a toilet. I'll give you an example, "Don't eat more than 15 in a sitting unless you are trying to power wash your intestines." The reviews are so good. Please find them.

If you're thinking of going low carb, you're now armed with some vital information. I am very, very, very much not a doctor but as a person who eats desserts for work and has to wear an elastic girdle under some of my clothes, I can tell you, in a literal pinch, I just eat protein and vegetables, I skip the grains, drink a lot of water, and say no to diet sodas. No sugar. That usually helps when I start to look like a walking cautionary tale. Or like a 1990s rocker mugshot. So anyways, that's my advice. Also, don't sue me.

Michelle: We've just found cutting out certain carbs can really help manage calories well. So instead of doing a sandwich for lunch, if you do a salad, you've saved 200 calories because you don't eat the bread. So, we'll do stuff like that a lot. And my family teases me all the time about it, and it's like, I know I study carbs but I'm also trying to stay in shape in grad school. You gain a lot of weight.

Alie: But there's also, like, an upper limit of how many carbs is a good amount of carbs, right?

Michelle: Yes, of course.

Alie: You get carbs from things other than bread.

Michelle: Yeah. Well, you know, being a glycobiologist, I can say you need carbohydrates to survive, obviously. It doesn't mean you have to eat, like, 16 pieces of bread. Like, I said plants are made up of carbs, so I mean, eat a vegetable and you'll be fine.

Alie: Eat a vegetable! I have questions from our listeners. Laura [phonetic] wants to know what your favorite sugary snack is.

Michelle: My favorite sugary snack… Donuts or cupcakes are kinda the top two for me.

Alie: And those have complex and simple carbohydrates?

Michelle: Those are mostly simple carbohydrates.

Alie: And what is the difference between complex and simple carbohydrates?

Michelle: So, a simple sugar… It's a little bit complicated to explain. Glucose you know of in, like, sugar, it makes up… it's a part of sucrose, that is the sugar that we eat. All that means is it's a single sugar molecule; glucose is a single sugar molecule. Well, there's different types of sugar molecules. There's also one called galactose and fucose, when those connect together, they make multiple sugar chains. And that's when they get complex, is when you get multiples of them.

Alie: This is a really dumb question, but why are simple carbohydrates sweet and complex carbohydrates, with more sugar in them, are less sweet?

Michelle: Oh, so that's just a characteristic of the sugar. Glucose itself is sweet, but then there's another sugar called mannose that's bitter.

Aside: So, the taste is just a characteristic of different types of sugars. I tried to look this up and explain it and I found this sentence that says: *Stepwise modification at each chiral center around the sugar ring allows the sapid functions in these molecules…* [*hem, um, pft…. trails….*] Anyways, some sugars are bitter. Some are sweet. That's all I got for you.

Alie: I'm sure that too, our body is, like, 'more sugar means more fat, means I live through the winter'.

Michelle: Yeah, I'm sure there's evolutionary aspects of it yeah.

Aside: Okay, carbs in the winter. Why do we eat them? Well, some people think that when the days start getting shorter and there's less light, we know WINTER IS COMING. And to survive the cold, you need feasts, and mead, and biscuits, and cookies your neighbor made. Now, other behavioral psychologists say it's just crimes of opportunity. The holidays mean more gatherings, and gatherings mean cheese platters, and crackers, and a bunch of caramel corn that you're gonna crack your teeth on but you don't even

care. I like the theory that everyone gets a case of the SADs: Seasonal Affective Disorder. A mild form of depression that your grandma probably calls the winter bluuuues. Depression can cause carbohydrate cravings, because carbohydrates promote the production of serotonin, which is a buzzy, happy, warm, feel-good chemical in your brains. Either way, let's chalk it up to good old-fashioned messed-up self-medication that brings us temporary joy and future misery.

I don't know how to end this aside. Oh, you know what, I'll just tell you that the largest loaf of bread ever made was baked by a Brazilian man in 2008 and it weighed 1,571 kg (3,463.46 lb.). It's one looooong-ass loaf pan that winds back and forth. The photos of its production before they cooked it look like an albino anaconda waiting in line at Disneyland. It was huge. Moving on.

Alie: Lucy [ph.] wants to know: Are carbohydrates your favorite organic compounds?

Michelle: Yeah?

Alie: Yeah? [airhorn] Angela [ph.] wants to know: Will there ever be a cure for Type 1 diabetes?

Michelle: I'm optimistic about that one. And that actually… that is a disease that a lab at the CCRC, and that actually in-general within glycobiology, there's a lot of focus on it actually. Yeah, I'm pretty optimistic about a treatment for that. There's a lot of labs focusing on that and they make a lot of progress. I think it's just in the world of research things take time, unfortunately.

Alie: She also wants to know: What impact do sugars and glycans have on gut bacteria, if any?

Michelle: Ooh. A lot. Yes, actually. So, your gut bacteria... like I said, bacteria express their own types of sugars too. And they'll have a different combination of complex sugars on their surface compared to our surface, our cell's surface. And the sugars that our body makes interact with the bacteria, like the bacteria will have their own carbohydrate-binding proteins. That's actually a really hot area of research right now.

Alie: Is that gut biome?

Michelle: Oh yeah.

Alie: So, you have these kind of glycan streamers that are jutting off of a cell surface. And those are interacting with your good and bad gut bacteria to be like, "Who are you? What are you doing here? What do you want?"

Michelle: Exactly.

Alie: So, you're kind of, or some glycobiologists, are studying how your cells interact with all the bacteria?

Michelle: With good or bad bacteria. Exactly, even just the basic understanding of, like, why a bad bacteria *is* bad. Like, how come your cell… how come the bad bacteria, like, infects your cell and the good bacteria don't necessarily? And that communication could be facilitated through glycans. It could be that the good bacteria have certain glycans that the cell recognizes and it's like, "Oh never mind, this is okay." And then the bad bacteria express a different combination of glycans, and your cell is like, "Whoa, no, you don't belong here. I'm calling in back up." Pretty much, yeah.

Alie: I wonder if there's any just like kind of medium bacteria that they're like, "I'm not really a dick and I'm not that nice either. I'm just kind of a medium."

Michelle: Maybe. There could be some that definitely are like, a mild… or just like, "I'm going to chill here and this is a nice dark environment."

Alie: You're never alone. It's a nice, dark, stinky environment.

Aside: I promise you that one day, I will have a microbiologist on to talk about the importance of the gut biome. It is all I want. If you are one of those, just slide in my DMs. I would love to talk about our stinky guts.

Alie: Jen [ph.] wants to know what is the most interesting thing about sugar on a molecular level? What does it look like?

Michelle: So, they're all, like, these little six or five-membered rings. So, if you think back to chemistry class, they're like little rings of carbon. Sugar is a glycan.

Alie: Oh, that's good to know!

Michelle: Yeah, they are all synonymous. It's really interesting, just a very small change means it's a different sugar and therefore it has a different property, everything from glucose being sweet to mannose being bitter. Those two structures are actually really similar, but one little change gives it a whole different characteristic. And that's, kind of like, the beauty of anything on a molecular level, is just that all the diversity, all the different cells, everything that makes the world that we see, it is just small, molecular changes that add up. If that makes sense. I know that sounds really dumb.

Alie: No! Does that ever trip you out from a from, like, 'what is life' standpoint?

Michelle: All the time.

Alie: Really!? Do you think about chemistry, like, when you're driving around? When you're just eating, when you're watching movies?

Michelle: No. [*laughs*] I'm definitely… I like thinking about science but I can also very easily turn that off and move on with my life.

Alie: You're like, "I can compartmentalize." Sarah [ph.] wants to know: Is it frustrating that our society has demonized sugar since glycans are so important to everything?

Michelle: Yeah, that's actually a really interesting way to think about it because, as a glycobiologist, I definitely differentiate the sugar we eat from the sugar on our cell surfaces. So, I see that distinction, but I totally realize that nobody else would see that distinction, and so they're like, "ooh sugar's bad," when really, it's pretty important.

Aside: Howe much sugar should we eat? This is a good question. I asked the American Heart Association; they recommend no more than around 30 grams of sugar a day. Particularly sugar. You're like, "Pfft, do I even eat that? Probably not." Wellll, the average American consumes 82 grams of sugar every day. That's roughly 66 pounds of added sugar consumed each year, per person. I found a site run by UCSF's med school called Sugar Science, they say:

> *Using brain scanning technology, scientists at the U.S. National Institute on Drug Abuse, were among the first to show that sugar causes changes in peoples' brains similar to those in people addicted to drugs such as cocaine and alcohol. These changes are linked to a heightened craving for more sugar.*

Now, UCSF has an incredible team of scientists studying sugar in the diet and its role in human health, and they have a Meet the Scientists page. It lists epidemiologists, psychiatrists, endocrinologists, and nutritional biologists. But no glycobiologists because the glycobiologists are really doing work at the cellular level with sugars and saccharides to find out how cells use them to communicate and to help find cures for rare diseases, which is why Michelle doesn't have a ton of interest in fad diets and I was up googling, 'Before and after pics Kardashian keto' longer than I really needed to be. Let's be honest. I really completed my research and then just kept looking.

Alie: Allison [ph.] wanted to know: How is glycobiology helping with developments of the skin and aging? And she also notes: I got this from Wikipedia.

Michelle: Yes! Okay. So, there is a particular complex carbohydrate chain called hyaluronic acid. And you will see that in a lot of your beauty products.

Alie: Yes, I think I've it smushed that on my face.

Michelle: In moisturizer. Yes indeed. So essentially, it has a long chain of sugars, a particular combination of sugars, that retains water really well. Like, it attracts water and water molecules stick to it, and it plumps up with… like, one chain can hold like a hundred times its own volume, its own mass, in water.

Alie: Oh wow! So, what is your least favorite thing about glycobiology? What do you, what really chaps your hide?

Michelle: It's weird because it's a combination of a thing I like about it and the thing I don't like about it. It's a growing field, but it's still a fairly small field, and so kind of everybody knows everybody, and everybody knows everybody's research. It has its pluses because, for instance, there's really only like one real textbook, like really good textbook for glycobiology called *The Essentials of Glycobiology*. So, it's a very close-knit community, which is nice, but it does mean anytime like two professors have, like, a beef or something, you know, like, your professor might be like, "No don't go post-doc in that person's lab because they suck." And so, it's got the same issues of any close-knit community, is that any of the problems kind of get exacerbated.

And it also means like our professional society meetings, for instance, when you go to these big conferences. Ours is pretty small. It's like 400 people, compared to, like, Society for Neuroscience is like 40,000 people. You know Society for Glycobiology is tiny.

Alie: Does that make you feel elite though? Do you feel like you're a member of a small, cool club?

Michelle: I never thought of it that way. I'm not really into elitism. No, it gives it a nice, like, family aspect, but it just doesn't give quite as much room for networking and branching out.

Aside: There may not be many glycobiologists, but Michelle says it's a really good skill set, it's starting to get some attention. The pharmaceutical industry is really picking up on it and there's a lot of room for using carbohydrates and their role in cell signaling for vaccine development. But still, I had to admit that I was stoked. I kinda fangirled when I met her and she said she's a glycobiologist.

Alie: I know when I met you, I was like, "I'm not going to encounter another glycobiologist for, probably, ever." So I was like, "Excuse me, can I pull you into this room?"

Michelle: Yeah. There you go!

Aside: So, what is her very very very favorite thing?

Alie: What gives you butterflies? Makes you get excited about getting into the lab, or just doing the work you do? What do you love?

Michelle: For me personally, it's thinking about it in a way to understand how this is going to benefit the communities, in particular these communities that are suffering from really rare congenital disorders of glycosylations, and that makes me really excited.

Alie: Do you want glycobiology to become a bigger thing?

Michelle: I do. As much as I say I like the close-knit family, I still want to see it become a common term. I want, you know, undergraduates to learn about it in science classes. I want pharmaceutical industries to realize it's important, and its importance, and hire more, and do more of its own research in glycobiology.

Alie: Have you considered shirts that say, "Glycobiology is pretty sweet"?

Aside: SHE HAD NOT. She did get memed by a friend: it's just a photo of her in glasses in the lab, with the all caps proclamation: GLYCOBIOLOGY IS COOL. I will post this on the Ologies Instagram because I feel it needs to be seen.

Alie: Do you have to wear lab coats?

Michelle: I do not. Nothing is going to, like, infect me in my lab. So, I don't worry too much about it.

Alie: But you could probably get so much respect at Starbucks if you waltzed in with a lab coat, just consider it.

Michelle: They're kind of hot, though. They're not a very breathable material.

Alie: Oh, I thought you meant that people look hot in them. Yeah, people look great in a lab coat.

Michelle: Nah, you get hot and uncomfortable. It's only nice because it has pockets, and if you're not, wearing… if you're wearing leggings and a T-shirt and you don't have pockets, the lab coat is clutch.

Aside: The lab coat is clutch. Words to live by with Michelle Dookwah. Also, please someone start that as a meme. Thank you very much.

Alie: Thank you so much for coming on. I'm so glad! I feel like I am walking away with a good grip on what glycobiology is. I had no idea what it was yesterday.

Michelle: I'm glad. That actually makes me really happy.

Alie: Yay!

Michelle: Yay Science Communication.

So next time you stare lovingly into a pita pocket, or you banish your cereal to a locked file cabinet in the basement, just remember that your cells are like koosh balls. All crazy with carbs on their surface, and they're all talking to each other, and waging wars on invaders, and you're just, like,

eating an apple on a bench, wondering if you should get an asymmetrical haircut this year. I say go for it.

To follow Michelle Dookwah, she's @MTDookwah on Twitter and Instagram, and Ologies is @Ologies on Twitter and Instagram, and I'm @AlieWard on both. If you want to find out what topics are coming up next and you want to submit questions to our ologists, you can become a patron at Patreon.com/Ologies. You can support with $1 an episode, you can do $25 bucks a month, or even one dollar a month. 25 cents an episode lets this show continue running, allowing me to pay the amazing Steven Ray Morris for editing and engineering, to pay for equipment, to pay for web hosting. Buying merch also supports the show and we have a ton up at OlogiesMerch.com, including individual pins that are so cute, for $8 each.

If you have any ologies or ologists you want to hear about, tweet me about them! Send me a message on Instagram. Join the Ologies Podcast group on Facebook. And thank you to everyone again who has left a review on iTunes, keeping *Ologies* in the top of the science charts. It only takes, like, two minutes, and I'm a creep and I read every one of them. And when I'm tired, or having a hard time uploading something, or run into a research cul-de-sac, it keeps me going so much to know that you guys are out there listening to the show. Because other than that, it's just me in my closet recording this. Which is literally what is happening right now.

Oh, and as for this week's end of show secret, right before I started recording this, I ate a slice of apple. And I realized I am currently digesting half of the sticker. I ate the slice of apple, I looked down and realized the other half of the sticker was still on the part of the apple that I hadn't eaten. I ate the sticker. So, if I die, it's because of my addiction to fructose.

In my absence, please ask smart people dumb questions, because they love it.

Okay berbye.

Transcribed by Kaydee Coast the outgoing accountant who collects rubber ducks.

And here are some links you may find useful:

Structure of sugars and their taste

Salt and Pepper syndrome

Extraordinary Measures on Rotten Tomatoes

Study on white vs. whole wheat bread

Ketogenic diet

World's Largest Baguette

Sugar Science at UCSF

Winter chub factor

How does sense of taste work

Sugar alcohols

Sugar free gummy bear reviews on Amazon

Autophagy

Glycogen depletion

Low carb diet

Ketogenic diet

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