Systems Biology with Emily E. Ackerman
Ologies Podcast
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Oh hey, it's your coworker that you had a dream about who you will *never* tell what the dream was about, Alie Ward, back with *Ologies*. This is an ology you've likely never even heard of. It was invented just around the turn of the century when Y2K fears were big, eyebrows were thin. Systems Biology. It's only been around about 20 years in name. And the National Institutes of Health says that different labs define it differently, but at its core – you ready for this? Here it is. – it's "an approach in biomedical research to understanding the larger picture – be it at the level of the organism, tissue, or cell – by putting its pieces together." It's like detective work but with math, and computers, and graphs, and stuff. And I'd put money on at least one of you who had never heard of it before falling in love with it and becoming this type of ologist in the future.

But before that gamble, let's thank everyone at Patreon.com/Ologies for supporting the show. It costs one cool American dollar a month to join, and you can submit questions. Also, thanks to Spotify for having us as your #1 Science podcast on there. Hot dang! Who ever thought? Not me. We stay up in the charts thanks to every kind soul who leaves us ratings and reviews, like this one from Will Gollyhue on Apple Podcasts, who wrote:

> *This show is like a red-carpet premiere with scientists instead of celebrities, and I just can't get enough.*

I'm glad you can't, because we have more for you in this episode, Will Gollyhue.

So this ologist and I met via Twitter. Last year, she wrote some really thought-provoking articles on the robotics scene in Pittsburgh and how errant delivery rovers cause a lot of problems for wheelchair users like herself. And she has written extensively about accessibility in STEM. She has a PhD in Chemical Engineering where she used data, and math, and modeling to figure out whaaat the fuck happens in the body when we're infected with a virus like the flu and what drugs might work best for whom.

We recorded this while she was still in the throes of finishing her dissertation, but now this doc is off to Cambridge to start postdoc work at a little place called Harvard Medical School, the Systems Biology Department there. She is smart, kind, funny, brilliant, and not at all a slacker (more on that later). So count your lucky stars you're about to learn about mathematics, computational science, Excel curses, career pivots, accessibility, identity, genomics, CRISPR, soapboxes, science, and more with advocate, scholar, and Systems Biologist Dr. Emily Ackerman.

Dr. Ackerman: Emily Ackerman.

Aside: Her pronouns: she/her.

Alie Ward: Cool! And now, you are a systems biologist, correct?

Dr. A: I am. I mean… by my own definition. I'm a chemical engineer by training, but most chemical engineers don't want to do chemical engineering, so we do other stuff. And my other stuff of choice is biology.

Alie: When you say 'chemical engineering', what exactly does that encompass?

Dr. A: Chemical engineering is very broad. We always think of it as the movement of heat, mass, and energy. It's been around forever and it hasn't changed in forever. So, the core curriculum that you learn is transport and thermodynamics, and that hasn't changed in, like, 100 years. So, I'm in a more biological area. There's also the energy area where people do alternative energies and fuels, batteries, and then they also do things like solar or biofuels and things.

Aside: So her chemical engineering department focused on petroleum and fuels, but she didn't work with petroleum. Her work involved more living things.

Alie: But you've always loved biology too?

Dr. A: Yeah. I love… It's so cool. It's such a mystifying place, at least to me.

Alie: Where did that start? Was it birdwatching, or was it documentaries about bugs? Did you have a microscope growing up? Where did you start to get really interested in the natural world?

Dr. A: So, being disabled and having medical conditions, I've always found the body very interesting. And understanding the ways that mine is different has led me to, kind of, explore a lot of biology from a younger age, I think. Once I got to high school when you really start learning and deciding what you want to do… I guess we force 16-year-olds to decide what to do with their life. It was a very interesting thing to me, but the definitions of types of engineering were, like, a real mystery to me and, I think, for most people. So I chose chemical based on the fact that I liked chemistry but I didn't want to do, like, lab science. So I thought, "Okay, I'll do more math."

Aside: She says at 16 she thought, "Hey, math sounds like a good thing to commit to. Math will always be there for you." And math is in everything. It's all around us like ghosts who make sense and have our back.

Dr. A: So I went into chemical engineering and then slowly migrated more toward biology when I realized it was way more interesting.

Alie: [*laughs*] And you… In order to be a biologist and in the biological sciences, there's a ton of patterns, and math, and chemistry that needs understanding, right?

Dr. A: For sure.

Alie: I mean, my type of biology is like, [*doofy voice*] "I sat on a bench and I drew a picture of a mushroom," because I'm not very gifted in the other way.

Dr. A: That's a great version of biology.

Alie: [*laughs*] But there need to be people like you who also can do applied topology and a lot of words I don't understand, which I understand is on your CV and I don't even know what topology is! So, how does math, and systems, and patterns… how do you get to apply that to the natural world?

Dr. A: It's a lot about the human body, and I specifically work with the immune system. It's something that, like the rest of your body, is in a very, kind of, precarious balance at all times. And the only time you really notice it is when it's out of whack. You're sick and your body is trying to compensate, so it starts giving you a fever, and you start trying to cough and do all kinds of things to get rid of it.

That's really the definitive example for me of how much we rely on math to exist but we don't think about it. What's happening within your body is the math is askew. Things are

out of balance. There's too much of something or too little of something, or even it showed up six hours too late. Whether it's your T cells, or something that you need to fight an infection, or even a gene doesn't get turned on. It's really an interesting view of math. And we can use math to describe all of the relationships within ourselves and all the interactions happening that keep us alive, which is really cool.

Alie: I heartily agree on that. "Staying Alive" is on my Cool List for sure. [*laughs*]

And if someone isn't sure what systems biology is and you have to describe it to them, how do you put such a big thing in such a small nutshell?

Dr. A: Systems biology is… I like to think of systems biology as the Frankenstein of biology. It's very young. Most definitions, you would probably see popping up 20, 30 years ago. It's really the result of having huge amounts of data, and needing to process it, and trying to do it in a way that you get a better system view. For example, you can invent algorithms to understand it. You can make models of it. And the goal is that you get this picture that you wouldn't get from just doing an experiment.

So, if I want to understand the immune response (which is what I do), I take data from real mice and I try to represent it with math or to work backwards if I don't understand really what's biologically happening. Maybe I can find some math that fits it, and I'd say, "Then this must be what's happening. It must be these two things interacting and causing this."

And one of the great things about what we do is, like, there's so much data just out in the world that if you have questions you can sometimes just find data to help you answer them, and that's kind of what you see happening with covid. There's this huge emphasis on making data publicly available and easy to use, which has a great effect on the scientific endeavor that I love.

Aside: Dr. Ackerman had analyzed infectious disease and influenza strains, but while getting her PhD at the University of Pittsburgh, she did a little pivot to a different virus you probably have not heard a lot about. It's called SARS-CoV-2. Just an intro to it. (j/k!)

I was eating fistfuls of sourdough all through 2020 and watching people make out on *Outlander*, but she was spending the pandemic trying to help us understand the pandemic… while getting a PhD.

Dr. A: I used to work only with the flu. Now I work with Covid-19.

Alie: Mm-hmm. Heard of it. Makin' headlines, yeah. [*laughs*]

Dr. A: You may have seen it. So, basically, my group deals with viral respiratory infection for the most part. I have, kind of, two major projects. The first is trying to identify important proteins that we could use as drug targets. And to do that I use network topology and analysis, which is a very large-scale, zoomed-out view of a cell. And then my other project is a very specific zoomed-in view where I write mathematic equations to try to understand the dynamics of the immune response.

So, the timing and the magnitude of response and how that differs between, say, strains of the flu, or between males and females, or any kind of relationship in hopes of better treatment strategies, better understanding of disease as a whole, because frankly we don't have a great idea of what's going on. And just kind of better understanding so that we can better address viral infection.

Alie: How was that pivot? How much have you had to pivot your research to covid? Which, by the way, that's amazing that you're working on it.

Dr. A: Thank you. Yeah.

Alie: Thank you for doing that on behalf of, like, me and literally the world. What was that pivot like for you? Was it exciting? Was it daunting? Was it really different from the flu?

Dr. A: It was a lot at once. When it hit, I realized that I could very easily apply the network study methods to SARS-CoV-2. I did it and it was just this giant whirlwind of, like, trying to get things out. It's very stressful to be working under that kind of time restraint; the magnitude of this problem. It's kind of overwhelming.

But it's really exciting at the same time to be able to help and contribute in the best way I know how. It's been a really interesting "make lemons out of lemonade" opportunity… Oh. That's not even the phrase! Make lemonade out of lemons!

Aside: *Tomayto-tomahto*. When life throws tomatoes at you, make salsa. Science is just all about confronting setbacks head-on, piecing things together with the info we do have, and adapting to new circumstances. That's why it's high drama behind the scenes and we love it!

Dr. A: The problem when such a novel virus emerges is that we don't even know what it looks like. And it's different for every virus. They have different evasion mechanisms or ways that they try to hide themselves.

Alie: And what does your work look like? If you were to, say, "Take Your *Ologies* Host to Work Day," I picture… Okay, tell me if I'm wrong.

Dr. A: I will.

Alie: [*laughs*] I picture that you have, like, six computer monitors and it's like when you walk into the control room at NASA, and it's all spreadsheets, and like *Minority Report* ["*blalalallal" like data flowing in*]. And you have several different input devices like mouses, or keyboards, or lasers. And it's just numbers flying by. And if I were there, I would just be trembling in a corner being like, [*a little bit scared*] "How do you keep track of all the numbers?"

Is that correct?

Dr. A: To a certain extent. [*DJ airhorns!!*] I've got two monitors. Very high up in the world.

Alie: Okay. [*laughs*]

Dr. A: Two monitors, five cups of coffee, [*laughs*] and two keyboards because I spilled a full cup of coffee on my laptop last year. [*laughs*] So, that's not great.

But yeah, I get told a lot that it looks very scary because I have… I learned to code from, like, an old man who's been coding since coding existed, so I code in the terminal in the worst visual way. And it looks very scary. People tell me all the time that it looks horrifying. But yeah, you're not too far off except it's less funded than you would think. Just turn things back, like, $100,000.

Alie: [*laughs*] Okay. Take some funding away. Who was the old man that taught you to code? I picture an old sailor in a park with an ancient laptop.

Dr. A: I did an internship with a pharmaceutical company, and he's very much the daddest dad that ever dadded. He just… He was just Doug, you know? A guy named Doug.

Aside: If anyone out there knows a very paternal guy named Doug who has taught people to code, tell him I love him. Am I exaggerating? No.

Alie: I love him. [*laughs*]

Dr. A: Yeah, I miss him.

Alie: Do you dream in code at all?

Dr. A: [*laughs*] No, but I have dreamed about covid and I have dreamed about, like, school things in general. It's a terrible experience.

Alie: Oh no! [*laughs*]

Aside: Let's move on from nightmares to flimflam, systems biology style.

Dr. A: I guess, like, that we spend all of our time, like, actively coding is the biggest thing. I spend most of my time either waiting for code to run because it takes, like, days, or googling the same error code eight different ways, or downloading Excel files of data and then searching for the one gene that is the same as a date so Excel converts it to a date and then you end up with, like, errors in your code because… yeah. Sept4 is my mortal enemy.

Aside: Of course I had to look this up! SEPT4 means 'Septin 4' and it's a protein that, in humans, is encoded by the sept4 gene, which also reminded me of the meme which is a Venn diagram of Excel and incels, both incorrectly assuming everything is a date. It hurts. So good.

Dr. A: But the amount of time I spend actually writing code is very small in comparison.

Alie: Are there moments where you've run data, or run an algorithm, or applied something computational to see if it fits with data and it works? Like, does your screen light up in gold glitter? What happens when it works?

Dr. A: I wish. It's like… I stop crying. [*laughs*] No. I mean, there's a problem in system biology and more computational fields where you don't always have validation for your answer. Maybe you need more data to prove that it's correct, or you have to very carefully design framing sets and things to prove that you have actually done something. So it can feel a little unrewarding, but sometimes it's the other way around and you're fitting to data that already exists or you have a way to validate it.

Aside: So sometimes it just points you down the path, but you're not quite to the destination yet. But at least you know that your work isn't a mess.

Alie: Are you a person that is super organized and analytical in the rest of your life? Are you, like, a person friends go to with computational questions? Or are you like, "I save that for work and I let the rest of my life be loosey-goosey"?

Dr. A: I'm a little bit of an organized person. I'm a very structured person. I love having a schedule. I love having rules to follow. [*laughs*] I'm that kind of person. At least rules that benefit me. But I'm also known as, like… not in a serious way, but the one who does math for a living but isn't very good at it. [*"Wait, what?"*]

Alie: [*laughs*]

Dr. A: Like, I'm always doubting my ability to do math.

Alie: Do people ever tell you to stop doubting your ability to do math because you're probably so much better at it than other people?

Dr. A: Yeah, I need constant reminders of where I'm at and how I got this far.

Alie: You mentioned something too about disability in STEM. And I'm wondering, is there anything that you wish you knew coming up that you wish other people in STEM with maybe any kind of disabilities knew?

Dr. A: Yeah, so many things. I think… What do I want them to know?

Alie: Sorry, that's a big question.

Dr. A: No, I mean… This is what I really am so passionate about. When I went to college I was very unsure like most college students are, I think, what they want to do or what they care about. I think one thing in particular is the fear that STEM isn't made for you; in a very physical way but also there's this emphasis on working long hours, on devoting yourself and therefore your body to the cause, whatever STEM cause you've chosen. And I guess what I would tell people is that that's unhealthy and false.

There's so much of a push to be a scientist or an engineer and to devote your whole self and it should be first. And I think what we know in the disability community is that our bodies and our minds have to come first. You can't do the science if your body's not there. So if you really want to be there, there has to be a way. So if you need to change your schedule, if you need to ask for accommodations and things because you want to be there, you are so in the right to do that and there's always a way that you can get to it.

The reason I do computational work is that I am very weak. I'm very small. I weigh like 50 pounds. I can lift, like, half a pound to a pound on a good day. And a lab is just not made for me in any way. It just will never work. And I knew that, and it's part of why I chose engineering. When I got to college, I was just by chance complaining to the professor how I was a little bit upset that I felt that there were no opportunities for me to do research because it felt like my peers were doing research that was going to get them into grad school or a job, and that I wasn't able to do it.

And he was like, "Well, don't you know anything about computational work?" And I was like, "Nope." [*laughs*] "Nobody told me about that." And he was like, "You've got to meet this guy." So I met my undergrad advisor, Dr. Curt Breneman, who does computational chemistry. And it was nothing like anything I'd ever learned, but I could do it anywhere, any time of day. It didn't involve lifting anything except my computer. And it was such an opportunity that I didn't know existed.

I didn't know anyone else that was disabled, students or faculty. So I really just had no idea that there's this whole world out there that I consider way more accessible science. So, one tip I would definitely say is to explore computational science. It's such a cool area and it's so much more accessible with the timing and the physical demands of it. And it's super cool and I want everyone to do it. [*laughs*]

Alie: That's so wonderful that just someone suggesting something like that can… It's so funny that those moments in our lives are like, "Wait, I can do *that*?"

Dr. A: Yeah, and if I'd known someone who was disabled, it probably would've been way more clear to me. Or at least I would've had some kind of hope that I could do it in the same way that my peers were just going up and asking for lab positions.

I am really passionate about not only getting more people into STEM but making it a place you can stay and foster the next generation of kids, like I was, who have no idea what the

future could even look like. It's so important that we make it equitable because right now it's definitely not.

Alie: Yeah. Anything that would make it more equitable? Any kind of moves that others could make or that you would love to see made?

Dr. A: Yeah. One big thing is just generally thinking about your lab space, or your lab policies, or even your classroom policies can be designed in a way that make it easier for disabled students and researchers to exist in your space. For example, if you're teaching a class and your policy in this strange pandemic time is that you have to always have your video on and you have to show up to every Zoom or you drop a letter grade, right?

It's really difficult for a lot of us to attend every lecture on time when there's no difference between watching a recording of it and attending it at a time. Or if your lab space… Most lab spaces aren't, disgustingly, accessible. But what can you do? You can not load all of your pipette boxes, and drug boxes, and everything right inside the door so that I can't even enter a lab, right?

Aside: And just a quick side note on identity and disability. Dr. Ackerman says she prefers identity-first language, i.e. she is a disabled person, rather than saying 'a person with a disability'. And this discussion comes up in the disability community a lot. Many autistic folks prefer identity first; 'autistic person' rather than 'person with autism'. So, deaf person, blind person, are also common choices.

Dr. Ackerman pointed me to a really great article written by Molly Callahan for Northeastern University which explains:

> *For people who prefer person-first language, the choice recognizes that a human is first and foremost a person: They have a disorder, but that disorder doesn't define them. For people who prefer identity-first language, the choice is about empowerment. It says that autism* (or a disability) *isn't something to be ashamed of.*

So now you know what person-first versus identity-first means, and when in doubt, just ask someone if they have a preference. Point being, disabled is not a bad word. And it's especially great to know this on the heels of July's Disability Pride Month, which celebrated the ADA, Americans with Disabilities Act, which is an example of person-first language on that one.

But major point: being disabled is nothing to ever feel ashamed of, as my good friend, TV writer, David Radcliff says: Disability will be a part of everyone's life, whether through age, illness, or accident. So we are either disabled or we are temporarily non-disabled." And I love that sentiment. It's really true for everyone. And also, David Radcliff is @DavidRadcliff on Twitter by the way. I'll link his Twitter on my website. It's great.

And it's also always wonderful to read articles by or follow folks on social media who are passionate about communicating these issues. Honestly, the best prevention for accidentally saying ignorant shit is just to learn and listen more in the first place. Boom.

Dr. A: There are ways that you can minimize the kind of effect that you have on your surroundings. I think what people assume is that when they see someone who is disabled, they say, "Ah, they're disabled." But the truth is, you can't always see it. In fact, a lot of the time it's very difficult to see when people need you to change the way that you operate. So, instead of waiting for someone to ask for accommodation, just providing it is the best way

to ensure that that person gets what they need without putting the onus on them to ask for you to change the way that you operate from your position of power.

Alie: That makes so much sense. And thinking about it ahead of time instead of waiting until you've put someone into crisis.

Dr. A: Right. And relying on that person to be able to convey to you that they need you to change is an even bigger barrier. If you… Like Twitter is popping up recently of community-building for specifically disabled in STEM folks, and they're great. I love interacting with other people.

Alie: Listeners, patrons, have questions for you. Can I lob some at you?

Dr. A: Ooh, yeah!

Alie: Okay. [*laughs*]

Aside: Sidenote, those Twitter hashtags are #DisabledinSTEM; that is a great one. And you can follow @DisabledSTEM to listen to that community and to get more resources.

And speaking of resources, before we lob questions, let's toss some money at a cause of the ologist's choosing. Dr. Emily E. Ackerman asked that it go to HEARD, which she told me via email is an abolitionist disability org that does a lot of work around the incarceration of deaf and disabled people. She says:

> *Our current carceral system is built from and runs on ableism, and disproportionately affects the lives of BIPOC disabled people. HEARD does an incredible job of centering disability justice with abolitionist thinking. They have trainings called "The Revolution Must Be Accessible" that I would urge people to take a look at, especially those organizing in their own circles.*

So that donation went to BeHeardDC.org. That is linked in the show notes, and that donation from *Ologies* in Emily's name was made possible by patrons of the show and sponsors who you may hear about now.

[*Ad Break*]

Okay, your systemic biological questions. Let's start basic.

Alie: Deenah wants to know: Do you see chaos in the mathematical models that you work with? And if so, when?

Dr. A: Yeah. We see a lot of noise in the models because everyone is different. So for example, I use data from, like, triplicate mice experiments…

Aside: Sidenote, I looked up 'triplicate mice' and it's not a type of mouse, I found out, but rather experiments run in triplicate using mice. So, more runs of the experiment means more data points, and then, thanks to this episode, I now picture data points like coins or mushrooms in a video game. Like, "*Pling, pling-pling, pling*. Get that data! Just shove it in your pockets!"

Also, if you're still staring off thinking about the mousies, we address perspectives on animal testing and its future later in the episode.

Dr. A: And even within those three mice there's so much variation and it causes a lot of mathematical issues; a lot of unstable systems. The nature of biological systems is feedback. Everything has a feedback system. And so when you make very small changes to

components of that system, you can get some really out-of-proportion results. So yeah, we see a lot of problems with noise and things like that.

Alie: I love that chaos and noise are, sort of, correlated.

Dr. A: Yeah, I don't know the exact mathematical definition of chaos off the top of my head, but I'm willing to bet that we see it.

Aside: Chaos. Noun. Behavior so unpredictable as to appear random, owing to great sensitivity to small changes in conditions.

So, little stuff makes things so sideways. [*"The shorthand is the Butterfly Effect."*]

Dr. A: Honestly, chaos is in everything, especially our bodies.

Alie: Right. And Kaitlyn Allen, first-time question-asker, wants to know… and this is specific, but if you have a favorite mechanism in organic chemistry?

Dr. A: Ooh. I don't because I barely passed organic chemistry.

Alie: [*laughs*] Okay.

Dr. A: It's funny. There's this, kind of, assumption that if you're a chemical engineer you must be very good at advanced chemistry. I haven't thought about chemistry in years, except for when I think about protein binding, but that's a very specific kind of chemistry.

Aside: If you're like, "I need a whole episode about molecular proteins and also being a queen of sci-comm!" see the Molecular Biology episode with Dr. Raven "the Science Maven" Baxter.

Alie: I thought Joe Porfido had a great question and it was seconded by Will Plewa, Erica Periandri, and Onyx Cassiel. Wanted to know if we could use viruses to cure a disease rather than cause one?

Dr. A: Yeah. There's some really cool work that goes on. I think it's called onco-virology or something. I made that word up, but it's probably close. It's the idea that you can treat tumors with modified viruses.

What happens when a virus enters a cell is that it triggers this series of events where your body says, "Oh, I need to start fighting. I gotta do something!" [*"Are we in danger of a hull breach?"*] So, it alerts all the surrounding cells with these small molecules called interferon. And they trigger all of these events that start bringing in immune cells and different immune processes to fight the virus. And the idea is that, let's say we could take all the scary stuff out of viruses and just leave the stuff that our cells recognize, and then put it near the tumor, and our cells would say, "There's something bad! We have to fight it!" It would start the interferon response, but instead of fighting a virus, because it's harmless, you would fight the tumor, essentially.

Alie: Oh!

Dr. A: I don't do anything like that, but I have read about it and I think it is super cool. There's lots of things you can do as far as messing with the genomics of viruses, and knocking out the harmful stuff, and using them to deliver parts of genes or just, kind of, cause controlled havoc. I think it looks promising and really cool.

Aside: Onco-virology or tumor virology it is. It's a thing! So if anyone knows of a good onco-virologist, please holler at me, at your DadWard. I'm all ears.

Alie: Zoltán Szászi says: This is a very interesting and important scientific area. Question: Is it possible to estimate with epidemiologic models (I don't know why I can't say that!) how likely it is for animal influenza strains like pigs and birds to cross the species barrier into humans? And if that happens, is it possible to guess how well humanity will do if another big flu pandemic breaks out?

Is that a number-crunching kind of question?

Dr. A: To my knowledge, no one is crunching that number. [*"Uh-oh!"*] It's such a random event, because it really just takes one event of mutation and then a jump from the animal to a human. I'm sure, statistically, you could figure out some kind of estimate. And this is one of those Fermi problems where you do back-of-the-envelope calculations of, like, "When will be the next pandemic?" You could definitely try doing that. I've never thought about it.

Aside: Ah, thinkin' about the next pandemic! Well, maybe let's get through this one first. I don't know. I hope everyone's out there getting vaccinated if they can because your health is worth it and so are others' health.

Dr. A: It's been interesting. As someone who… If I got covid I would be in very bad shape, just given the nature of my health. It's been interesting to see the way that people, kind of, write off other people in their estimation of danger. So, they're thinking about "Oh, I'll be fine. I don't get very sick usually." They're not giving a lot of thought to people like me who can't leave their house at all – and when I do, I'm at a super high risk – and what steps they could be taking towards people like me, or their grandparents, or their mom who just had surgery or whatever.

Aside: This was actually recorded before the vaccines were widely available, when the best we could do was distance, and mask up, and wash our groceries. And as the Delta variant picks up right now and the masks go back on, just do what you can out there to protect each other. Some of the people you're protecting are the very people working on the science to get us through this, like Emily.

Alie: To just be like, "DO YOU REALIZE WHAT SHE'S DOING?!" [*laughs*]

Dr. A: "I'm trying my hardest!!"

Alie: [*laughs*] You're, like, the one that's fixing it!

Michael MacLeod has a question, first-time question-asker: What are some advancements being made now using systems biology and synthetic biology approaches that may not have even been possible 10 or 15 years ago?

Dr. A: Ooh, yeah. Well, we're always coming up with new experimental methods that give us better data, which is a big barrier to addressing these kinds of problems.

Aside: Emily says that better imaging helps system biologists have a more accurate grasp of pathologies, which is helpful for number crunching and analysis.

So what does this mean for you and your hot bod?

Dr. A: Similarly, like putting humanized versions of cells into mice or rabbits and things so that we can get a closer idea of what the human response would be, but in a rabbit where we can test it well. That's a very new concept that's really advancing our concept of specifically human response.

And then on the computational side, the more data we have the more advanced algorithms we can develop and the models that we build are more biologically accurate; more

encompassing at least. And my goal in everything I do is better personalization of treatment. How can we better understand late-stage infection behavior based on early signs or early dynamics of immune cells and cytokines and things?

Aside: And in the various coronasodes we've done over the last year and a half – which, it seems longer – we've mentioned that cytokines are the small proteins that allow your cells to communicate messages to each other, essentially, and a cytokine storm is like your immune system's phone just blowing up, going on overdrive, and having system-wide inflammation that occurs. And it can be pretty dangerous, especially for covid patients; sometimes leads to organ failure.

And systems biologists help figure things out like, "Okay, based on a patient's Day 2 covid data, who's going to be in the ICU on Day 10, and what medications are more likely to work on a system-wide inflammatory response?" So, she's working on that.

Alie: So people who think that math is, maybe, not their thing, or systems biology is not their thing, it's really like, essentially, a crystal ball. You're essentially, like, a wizard. If you can crunch the numbers, you can predict the future. What's cooler than that?

Dr. A: That's the goal. Yeah.

Alie: It's like a Magic 8 Ball but based completely on math and accuracy.

Dr. A: Right. And it's almost like waving your hands and clearing a weird fog. Like, "Maybe these two proteins do it," and then I wave my hands and "They're binding at this affinity."

Alie: Oh, that's so cool!

Aside: Speaking of looking into the future:

Alie: I have one more question, and it deals a little bit with what you were just talking about with animal models too. Two different patrons, Ruby Oestreich and Erica Periandri both asked if you see us in the future moving away from animal models by using, like, bioengineered human models or just by using math? Ruby says: I really struggle with science and animal cruelty. And Erica says: As a vegan and a scientist, using animal models kind of hurts my heart. But maybe bioengineering or systems biology might be able to get around that.

Will quantum computing help us solve that? Where is it going, do you think?

Dr. A: We're definitely headed in the right direction, I think, as far as… We're always going to need data. It depends on your application. I could see some of them going much closer to no-animal models. I'm thinking, if you work with a very specific tissue type and you only work with that, you're probably much closer to going animal-free, and so… It's a much harder question. But I do completely agree, and to some extent it's difficult to get out of my head, the animals that we have to use. As a computational researcher, I don't have to do it myself, which I'm thankful for because I think I'd be a big chicken.

Alie: Yeah. I think I'd be a big chicken too.

Dr. A: Yeah, I have friends who do it. I'm like, "I don't know how you do it." We really do everything with the least amount of data that we can possibly scrape by with 90% of the time because it's so hard to get data. So, we really do try to minimize the amount of data that we use for that reason, among many.

Alie: And as long as I've taken us on a detour to Bummertown, what is the thing that is the most upsetting thing about what you do, or something unexpected that you just hate about systems biology? Any bones to pick or any grievances to air? Feel free to have a soapbox.

Dr. A: You know, I do have a large soapbox. [*laughs*] This is, like, something that I try to be vocal about whenever I can: the pervasiveness of eugenics in disease research can be very tough to be a disabled researcher, and human, and be exposed to. And none of this is a systems biology-specific problem. There's a lot of assumptions that go into biological work as far as… that people with diseases would not like to be the way that they are, or that there's some kind of inherent goodness in sorting people in any way based on genetics… or some inherent truth, I should say. So, it's tough to watch people who do disease research and have probably not much exposure to those people who are affected.

And from an activism standpoint, it's really scary to watch a lot of movement in that direction as a positive change. For example, last year, I think when the genetically modified children were exposed in China… I don't know if you remember when that was a thing, but for background, they basically had genetically modified the embryos so that the children didn't have whatever genetic disorder the parents had.

And in the science community, that was enough of a red alarm for people to be like, "No." On the whole, in the world, it got a lot of traction as, like, "Is this the future? Are we going to eradicate disease?" And it's just such a harmful mentality to think that people would be better off without their genetic disorders.

And obviously, there are things about it that are valid to think about, like life-threatening illnesses and things like that. That's a conversation that should be had by the people with those disorders. But the harmful nature of those conversations happens when it's just the people in power doing the science, or funding the science, or spreading the science, who really don't consult with the people that are on the other end.

When you talk to the disability community, there's this huge push within advocacy to call out these kinds of eugenics for what they are. Because they're so accepted by the public as something that's good because it's eradicating something that's implicitly bad to them that we don't get heard when we say, "I don't want to be different. I don't want to be genetically modified, and I wouldn't want my children to be genetically modified."

So I do wish that people would be more cognizant of the ableism and the eugenics that are so deeply ingrained into science. And listen for people calling them out, people like me. There are a lot of us who are actively out there yelling about it. It's been really interesting to see the way that non-disabled people have framed the conversation about disability, and genetics, and the scientific way.

Alie: Where can people listen to your voices and get a more balanced picture of that?

Dr. A: Yeah, the great thing about the disability community is that we are all super online, [*laughs*] because of the nature of our lives. We organize virtually. So, Twitter is a great place. I would recommend any written piece that is written specifically by a disabled person. And I think just being cognizant that the opinions that really matter on this debate, which should not be a debate for most people, only for us who are affected… We are the ones who matter in having our voices heard.

There's a lot of articles written by people who have no connection beyond understanding CRISPR, and it's very disappointing to see that platform given to them when they don't, frankly, know what they're talking about.

Aside: This is, of course, a really important topic, and this conversation with Dr. Ackerman really opened up my own eyes to the issue. She sent me an email after we recorded because she just wanted to expand on it and get her thoughts down. She wrote:

CRISPR and gene editing are absolutely incredible scientific technologies that have revolutionized the way we're able to address biological problems. I know that as a scientist there are a million ways to use it for good. However, in combination with the ableism ingrained in our societal teachings, blatant or unrecognized, it stands as a not-so-far-fetched weapon against the identities and the lives of the disabled. The failure of the scientific community to widely condemn the detrimental idea of editing our very disabled existence, and the suggestion that it represents an optimal future to do so, combined with the very extensive history of eugenics leads me to actively fear my colleagues' potential role in the downfall of the community I love so much under the misguided ableist idea that all those with disabilities would be better off without them.

The day the Nobel prize was announced for genetic scissors, a tool for rewriting the code of life, my Twitter feed was 50% scientists who were elated and 50% disabled people who were saddened, angry, and scared. The science community needs to bridge this divide and seek out voices of disabled individuals themselves, not their families, who are proclaiming their joy and renouncing the idea that there's something wrong to be fixed. If we don't have this very personal conversation now, it'll soon be too late.

She also sent a few great articles on identity and I'll link them on my website at AlieWard.com/Ologies/SystemsBiology. That'll be linked in the show notes, and I'll also include some hashtags and some articles that she recommends.

So yes, gene editing on humans. Not as simple an issue as just putting an Instagram filter on your vacation photos.

Dr. A: I mean, when I say that it's very rooted in ableism in that it's a projection of, like, fear, I think. That's how I see it. People are worried about, what if they had a genetic disease? Or what if they had a child with a genetic disease, and how that would affect their lives. But it's really… You know, it's great. I love being disabled. And I know that everyone doesn't and I fully respect anyone's right to say that they do or don't. But too often, you don't hear the voices of people who love being disabled. So, yeah.

Alie: Because we don't get to hear those voices, can you tell people what you do love about it?

Dr. A: Yeah. I love the view that I have on life and how inherently different it is. I think that there are things that I think about all day every day as far as getting my basic needs met, and how I'm going to plan my next career steps, and that's the full gambit of, you know… the most disabled thoughts are like, "How am I going to pee tomorrow?" Or "Do I have all the medicines I need, and how am I going to get them if I can't leave my apartment?" To "What am I going to do next year when I have to graduate?" These are, like, the full spectrum of my most disabled-specific thoughts to my most generalized, everyday, all-of-my-peers-have-them thoughts.

But I love that my view on those everyday questions that everybody has to answer is so tinted by my disability in a good way. It's that I'm thinking about the city's accessibility, and I'm thinking about the political climate, and I'm thinking about all these factors that I think are going to help me make a better choice. But it's because I have to think about them.

Alie: It sounds like a richer experience because not only do you have to consider your needs, but it also must make you considerate of other people's needs across many different spectra, you know?

Dr. A: For sure, yeah. I love the intersectionality of the disabled community. There's one of everyone, and then some. It's so easy to find someone who is the complete opposite of you

and someone who shares so much with you in a way that I don't find in everyday spaces because there's just so much more to talk about and to have an experience about. It's just so exciting to meet other disabled people and learn so much about, like, what it's like to be them.

Alie: And what about systems biology? What do you looooove the most?

Dr. A: I love thinking about the scale of it. I've had the network project, which is very zoomed out. I look at all proteins of the cell at once and very generalized, "Yes or No, do they interact? What can we learn from that?" And then I can look at just singular interactions or a very small pathway of interactions, and the details of such a zoomed-in view are just so… there's so many details. And you can always go smaller, and they're so interconnected. But on a tissue level and on a whole-body level, just very small changes at such a small microlevel can cause huge differences in what our body does and how we perceive ourselves.

I just love thinking about that view. Kind of the way I love thinking about space but it makes me really afraid when I think about space. When I think about my body, at least there's, like, a small limit that I can think about.

Alie: That's funny. I found out there's a word for that called cosmic vertigo, when you just start thinking about how big space is and you're like, "WaAaAaAa…"

Dr. A: Ooh!

Alie: But as you were saying that, it was funny because I was picturing you in this, like, tiny rocket ship and you're able to go from, like, the outer edges of the universe to, like, all the way zoomed into, like, molecules. And systems biology is, essentially, like the spaceship where you can hyper-speed, *zroom zroom*, to all these different perspectives, which is so cool!

Dr. A: It's very cool. You can just do whatever you want.

Aside: So, definitely follow Emily E. Ackerman on Twitter, although her display name, I take issue with. Emily *Slacker*man?

Alie: The only bone I have to pick with you is that your handle is Emily Slackerman Ackerman. And I was like, "I highly doubt the 'slackerman' part!"

Dr. A: That's actually a very long story. An internet troll bequeathed that to me. I took it and just ran with it. I was like, "This is how I want to be… I want this on my gravestone. I want to be known as this for the rest of my life." They thought they were really burning me. Actually, they gave me the greatest gift I've ever received.

Alie: [*laughs*] Emily Slackerman. Now I love it even more. Oh my gosh. Thank you so much for being on. I'm so excited that I now know what systems biology is and how cool it is.

Dr. A: I hope that everybody knows now.

Alie: They do!

Dr. A: Well, like that *SNL* skit with, like, "The hottest club in New York City!" But it's systems biology.

Alie: [*laughs*] Oh my god.

So ask systems biological people simple questions and you'll get to know your world and the people making it better, better. You can follow Dr. Emily E. Ackerman, who is @EmilyEAckerman, aka Slackerman, on Twitter. And her website is EmilyEAckerman.com. And if you'd like to hear her on more podcasts, you can check out *Disability Visibility* hosted by Alice Wong. And Dr. Ackerman is on Episode 91 talking about disabled engineers, and I'll link that on my website too, as well as a link to HEARD where we sent a donation today at Emily's kind suggestion.

We are @Ologies on Twitter and Instagram, and I'm @AlieWard on both, so do be our friends. Thank you, Erin Campbell Talbert, for adminning to *Ologies* Podcast Facebook group full of very swell humans. Thanks, Boni Dutch and Shannon Feltus, for managing merch. They're also sisters who host the podcast *You Are That*, which is very funny. Thank you, Emily White of TheWordary.com for making our transcripts. Those are up for free to anyone who wants or needs them. Thank you, Caleb Patton, for bleeping episodes in case anyone needs those. We also have new family-friendly episodes called *Smologies*, and they are classroom safe. A new one is due out this Thursday.

Thank you, Noel Dilworth and Susan Hale, for keeping the trains running and helping with social media posts. Thank you, Kelly Dwyer, for making AlieWard.com. She's available to make your website at KellyRDwyer.com. Thank you to my legally wedded hunk and editor Jarrett Sleeper of Mindjam Media for making these episodes into the dark of night. And of course, to Steven Ray Morris of the podcast *See Jurassic Right* and *The Purrrcast*. Nick Thorburn wrote the theme song and is in a very good band called Islands, which has a new album out right now called Islomania.

And if you stick around 'til the end of the episode, I tell you a secret. Sometimes they're embarrassing, sometimes they're things you don't want to hear. This one's a lifehack. I want you to know it so I'm going to say it with my mouth.

So, take a pitcher, right? Fill it all the way up with ice. Juice three limes into it. Then you fill it with water. And for some reason, lime water is like 1,000% more refreshing than lemon water. I don't know why. It's all the summer delicious of a margarita without being hammered or sugar crashing. So, love some lime water. All about it. Make yourself some. Canned lime juice? Bottled lime juice? Get away from me with that. It doesn't count. Just get some real limes. Get one of those citrus smasher-squeezers. Whoo! Your life's going to change.

Also, NightShade3621 and YoGabbaGabbayo, I read your reviews too. And one, congrats. That's amazing, Nightshade. Two, YoGabbaGabba, I'm a supermarket witch and I can see you.

Stay tuned for new *Smologies* on Thursday.

Berbye.

Transcribed by Emily White at TheWordary.com

More links you might enjoy:

A donation was made to HEARD

Dr. Ackerman's essay: "My Fight with a Sidewalk Robot"

Dr. Ackerman's recommended reading: "Here's a list of writings/thoughts by disabled people about their relationship to CRISPR and gene editing. These are SO useful and important for wide scientific reading."

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Person first vs. identity first language

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