Eric Hall: Welcome to the next episode of Destination Biotech. I'm your host Eric Hall and I'm here today with my co-host.

Matt Shafer: I'm Matt Shafer, the Biotech Student Outreach intern.

EH: And we're here today with our guests, Associate Professor in Ag and Biosystems Engineering, Dr. Adina Howe. Welcome.

Adina Howe: Thanks for having us, Eric.

EH: And also along with her is Nicole Geerdes, a first-year grad student in Dr. Howe’s lab. Welcome.

Nicole Geerdes: It's great to be here today.

EH: So we're really excited to have Adina and Nicole here with us. We've had really good relationships with the Howe lab over the last few years, developing curriculum materials, hosting Research Experience for Teacher

teachers as well, and we're excited to extend that now into the the podcast world. So first let's start off, just tell us a little bit about your journey, how you ended up here at Iowa State doing what you're doing, so that everybody has an idea of what your path has been. So, Adina, you want to start?

AH: Sure. So I was an engineer by training. I thought I was going to become a mechanical engineer when I was an undergraduate. I liked tinkering. Back in graduate school I had the opportunity to really think about what I wanted to do as far as helping the world. And at that point-this will date me quite a bit- that, the word “sustainability” first became invented and as a 21-year-old I thought that was so cool. We're going to save the world, we're going to do something impactful around the environment. And it really drove me to move into environmental engineering, which is where I learned about microbiology and the role

it could play in the environment as these invisible living creatures that are so important to our bodies the environment and how we're connected to it. So from there I really got interested in research and then I really

got interested in just working with people doing research and that brought me into the academic space.

EH: Excellent. Nicole, how about you?

NG: Yeah. So, I grew up in Cedar Falls and I did my undergrad at UNI, so I've been- I've always been in Iowa, and I guess the kind of questions that we're trying to ask and answer in Adina's lab are really impactful to Iowa and the Midwest. And so I think that's kind of why I find this type of research so interesting and to like have a tangible impact on not only our generation but future generations is really important to me. Yeah, I got involved in undergrad research and then I just found myself in grad school a few years later and I think that's how it usually happens…

EH: and you didn't want to leave.

AH: She hasn't left yet.

EH: So one of the questions that I always like to ask people has to do with where your mind was back in maybe late elementary, middle school, high school- that's who our audience is for these podcasts- so think back if you can to where you were during those years. And I mean did you see yourself ending up where you are now or what was your thought at that time? What did you want to do? How did you see your future kind of playing out?

AH: My answer is so ridiculous I should not go first.

NG: Yeah, I guess for me, growing up, I think that I was always interested in just learning about anything, being able to find problems to solve, and ask questions always interested me. And then, going I guess a step further into my like higher education career, I was a first-gen student, and so I didn't really see myself going into research. And so I actually didn't even know it was a possibility until I started doing it. And then I was like wow I could actually do that. So looking back on it, I can see like, I guess, like a trail of crumbs like leading me to where I am now. But in the moment I never would have thought that I would be here.

EH: Were there, were there moments or individuals who maybe gave you that spark at some point? Or was it just you thinking this is where I, this is where I want to go?

NG: Yeah, I think for me it was probably my undergrad research advisor that was really like, you know, you're kind of good at this. Like maybe you should think about like actually doing this. I had planned on going on to professional school, maybe thinking like genetic counseling or PT initially, so where I am now is definitely a lot different than where I thought I would be going, but I'm happy.

EH: Yeah, well that's good. That's the important part. So now what's the other story Adina?

AH: Well, I went too far back. I was back in kindergarten.

EH: It's only a 20-minute podcast.

AH: Sorry. So I wanted to be a fireman's dog. I thought that'd be super fun, but I was always pretty attracted to math and science, and so it was a natural point for me to be recommended as a field for engineering. I really didn't know what it was. But then I got to the point where it was almost a competition because at the time when I was in engineering school there weren't many females in engineering. I think that's becoming more balanced now. We still have a lot of work to do, but it was almost like well let's start this game then. So I really- I'm a pretty- I'm not a- I wouldn't say I'm a competitive person by nature but if confronted by a challenge I'm not going to back off so… Maybe people would disagree with the competitive part too, I'm not sure.

EH: I don't know. You said yes to this, so I feel like that's probably true.

AH: Yeah.

EH: So let's jump into a little bit more about your research here, what it is that you two do. We've talked a little bit about water quality in past episodes. You're part of the same research group as some of our other guests, but we want to talk about what you do. And so just kind of a general idea of what your research projects look like, the kinds of questions that you're answering, and maybe a little bit about how you develop those questions along the way.

AH: So maybe broader than water quality we really look at environmental quality, from soil to plants to water, and how they're connected in our lives. And there's lots of reasons to study water quality. One is human health. I mean, we're drinking water, we play in water. So from the health side we want to make sure it's clean. Another reason we study water and what's attached to water, whether it be soil or how we practice agriculture for example, is because we want the environment to look nice, right? We're in Iowa. A lot of people enjoy recreation in the environment and you want to enjoy what it looks like. If you came here hundreds of years ago you'd experience a very different landscape. We've changed that landscape in a positive way in that we feed the world. I would argue we changed it in maybe a negative way, and that approaches that feed the world have sacrificed maybe some of the environmental quality- not maybe, it has sacrificed the environmental quality that we can enjoy. So the question is how do we find a balance in living the way we do and enjoy, for our children, but yet still provide quality in the resources around.

AH: And so how we do that is we team up with people who study many different things chemistry, environment. But we specifically look at the microbes, and microbes are interesting because they cycle a lot of the nutrients and they govern a lot of the ecosystem functions that keep the air clean, keep our plants growing, and they naturally are able to take care of many, many things that we can't. For example, in our bodies we have microbes that digest our food and provide vitamins that we cannot, we can't get from any other origin except for the microbial metabolism. I think it's B12 that we get from that.

EH: Hmm. (B12 is correct!)

AH: So, we look at the lens of how do these microbes act as either a source of environmental response or function?

EH: So taking all of that into consideration, what are some of the questions that you ask and maybe a little bit about how you develop some of those questions because there are lots of things that you can study. So how do you narrow it down, especially in your role as a graduate student? How do you determine where you're going to focus?

AH: Yeah. And I think Nicole is a great person asks because she's a first-year graduate student coming up with her own questions. And so in graduate school it's really special because you're trying to find a question that no one has really answered and contribute to this knowledge

that isn't there. And so it's, it's quite an experience to figure out where your curiosity lies within something that needs to be filled in. And so maybe Nicole can talk a little bit about her journey there.

NG: Yeah, I think trying to figure out which questions to ask is kind of, it's nuanced, and I think that it really depends on- I mean someone has to like pay for our research, right? And so like other people who are going to fund these questions need to think that it's also important. And I think that kind of innately comes along with the things that we do in our lab, being in Iowa and being really focused on agriculture and agricultural practices, and I think, you know, farmers and agricultural companies are more inclined to support questions that ask, that want to figure out, I guess, what kind of impacts they're having on the environment because people are more concerned about it today and I think rightfully so. And I think a lot of people find those types of questions interesting because you can have a really large impact by you know finding even just like the smallest piece of knowledge that could be a key piece in the puzzle to understanding what's going on in the environment.

MS: So, share with us what does it look like in your lab? How do you actually answer these questions? What are the things that you're doing as you do research?

AH: Great question. So one an analogy that might be helpful is to think of microbes, the individual microbes in, say, in a soil or water context that there are millions of them there, but our methods treat them like a population and we want to do a census on that population. We needed to know what their different traits are. And so what we do, and it boils down to actually the advances in sequencing technologies and our ability to identify who they are and what they're doing, is we are able to get water or soil and then grab the data that is equivalent to the traits of a census. And this could be metrics like diversity or the number of microbes that move nitrogen or the number of microbes that are pathogens in different environments. We pair that with experimental conditions like, well, what happens if we till soil or don't till soil or put manure on or don't put manure on? Or what happens in May in a harmful algal bloom conditions or in December when the lake's frozen? What are the microbes doing differently?

AH: So the question of this paper is there's a conservation practice called prairie strips, where we plant at the edge of a farm field prairie strips and they’re exactly what you might think they are. They're little strips of a prairie that intercept- their goal is to intercept water flow to treat it before it goes downstream. And the question is- was would the

installation of these Prairie strips then help manage some of the pathogens that might come from manure application? And so the experiment here and this figure shows us here- so you can see prairie strips in their glory, and panel A here at the edge of the field.

AH: The experiment here though is to study then a little plot, or multiple plots actually, that have just a strip planted on there and we didn't apply manure to this plot, this is our control plot. So these are no manure-strip control. And then we have the same thing but we put manure on it. So we're going to compare those two. And then we also have another control where we have no strip. So this would be something where no one did a conservation process. And the question is what's the difference with this strip? So what happens is then we put a little rainfall simulator on top of these plots. We put rain on it. And after half an hour, you can see those gray bins: imagine them down slope, and that's where we collect water. And we want to know in that water, are we seeing a lot of pathogens? And so if this went as planned and prairie strips did an awesome job, we would see in this water or the sediment coming off these fields, lower pathogens where strips are implanted. That's what we want to see. So that was the question for this student and the student is now at the USDA.

AH: And so when I talk about traits that can be measured the census that can be measured in the microbial community, on the X-axis, you can imagine these as traits. These are things like height or gender or maybe, maybe smoking or non-smoking, if you can imagine that for the microbial population. And then we just track like the number of microbes that have those traits. And so that's just an example of how this data plays. And so what you can see here is we can compare traits in manure versus traits in water. We want to know what that looks like at his baseline, right, because we want manure to look like water. If manure looked just like water this experiment would already fail. So from this plot you can see there's certain traits that are specific to manure, right? It doesn't matter if you know what they are, but there's some where the gray dots are much higher than the blue and orange dots which are just control runoff water and sediment from non-manure plots.

AH: So if you go to the next slide, and I will probably- this is just, this gives you just a fingerprint. So if you think, you can also think of a CSI analogy here; you're forensic-ing. The manure fingerprint looks so different than stuff that doesn't have manure on it, right? And so if we look at the water coming off these strips, if it looks like that manure on the left you're like, “Oh, the manure microbes are in the water: bad!”

maybe. And maybe, and where the prairie strips are installed, it looks less like that. Right, so that's what this experiment's about.

AH: And if you go to the next slide, it's actually the results of the experiment. So where are we looking at? First, we have our baseline manure fingerprint that's on the left column, like the rainbow oranges. And where do you see that manure? We don't see it where we see strips and no manure application, right? That totally makes sense. No manure is applied. We shouldn't see a manure fingerprint. But look at the ones where the no strip and the manure plot 7 through 9. Look how that looks like the manure, right? The manure is coming off the farm field. We don't have a strip installed and the water coming off of that looks like manure. We're seeing manure microbes come, the traits of manure microbes come off. Right- Nicole do you see that? This is the first time Nicole’s seen the slides too.

NG: It is, yeah.

AH: But look at the middle one. That's the one where we installed the strip, right? So the strip's been installed at the edge of the field. The water is being collected. Do we see the manure pathogens coming off? No not really, in plots 5 and 5. In plot 4, you can argue, “Well, something's going on differently.” That's just field variation. That's something we're always struggling with when we do field experiments. But this is the type of stuff we're doing with the census data and the context of how we use this kind of trait characterization to get at what's happening. So this is often the sort of design we're doing.

EH: So how does, I mean, this is part of a scientific paper and that's one of the ways that scientists communicate their findings and conclusions that they might make. How else does that happen? How does the information that your lab puts together get to the people that need it? Are there other ways or is a scientific paper the only way that that happens? I mean how do you share what you do?

AH: Well, we do podcasts every once in a while.

EH: Yeah, I was gonna say…

AH: Often the students will go to conferences and present, there's different, and that's a really great experience for not just presenting the information but about learning about different information. There's, you know, working with extension partners like you to figure out what's the best impactful communication to the different- I think it depends who

you're trying to communicate to because you want to be very effective at that communication. And honestly, we're not all trained to communicate effectively to all audiences. So sometimes we need to partner with the right partner to figure out how to say things well. But from the academic research standpoint it's often papers and conferences, and of course you guys communicate to each other. Students are always chatting with each other about their research. That's an important, I think that is diminished, because we don't give any credit for how much you guys talk to each other, and how impactful that is for your learning.

EH: So what does that look like in a lab group like yours? What does that communication look like? Does it take the form of meetings or is it mostly informal? Or how do you structure that so that you make sure that

everybody knows what's happening, at least to the extent they need to for

their own project?

AH: Nicole how do you communicate with it?

NG: Yeah, I think we do have like formal lab meetings where, I think, everyone gets a chance to present their work and I think that's when everyone really gets caught up to speed on, like, everyone knows what

everyone's doing in those meetings. But I think where the real work comes down is like when we're really struggling and we're like, “Hey, have you done this before?” or like, “Do you have any suggestions for me?”. I think that's when like the best collaboration actually takes place is when you like partner one-on-one with someone else in the lab and, I guess really get to use their expertise to build on your own.

MS: So, Adina within your lab, everyone's working on a different facet of this problem with water quality. So, Nicole do you maybe want to share about what you're working on and how it fits into the big picture?

NG: Yeah. So, Adina talked a lot about, you know, sequencing efforts and there's been a lot done when it comes to plant microbiome and how not only bacteria, but fungi, can also impact the, I guess, plant growth and how they acquire nutrients or how they respond to abiotic stressors. And you can answer some of those questions by sequencing, but I think if you want to get into applications for the field you have to be able to grow those in the lab. And so my project kind of looks at a set of isolates from a specific plant and how those might affect how it grows. This is

important I guess and kind of goes back to the overarching questions in our lab because if we can figure out a way to, I guess, make these bacteria work for the plant, we can reduce the amount of, I guess, chemical inputs or herbicides or things that can end up in our water and affect water quality downstream so...

EH: So, we appreciate the conversation today. Any words of advice for our audience here? We're looking at kindergarten through 12th graders potentially. What advice do you have for them becoming scientists, working as a scientist, and maybe eventually ending up here at Iowa State?

AH: You want to go first?

NG: Yeah, I think just to be curious, remain curious, and don't be afraid of maybe asking the wrong questions because we all do at some point and it'll lead you to the right one.

AH: Yeah, you should eat your vegetables. Research about how it affects your microbiome, especially broccoli, is good for you or any vegetable that looks like a tree. Brussels sprouts also. But I think maybe my piece of advice, and I talk a lot about this with my students and also my children, is the idea of failure and what it means. To solve a hard problem you have to fail. And so you have to figure out how to be resilient beyond that failure. So you've got to you've got to be able to fail to be OK with it. And that's really something that I find that's really difficult, especially for kids, and adults, but especially for kids because you're always driven to be successful, right?

EH: Right.

AH: So it's kind of different in the research space.

EH: Well and failure can be a form of success, right?

AH: It has to be to solve problems

EH: Right, right. Excellent advice. Excellent. Well, we want to thank both of you for being here. Adina and Nicole, thanks for joining us for this episode of Destination Biotech. Matt, thank you for being here as always.

MS: I'm always happy to be here.

EH: He is always. Next time we'll be joined by Dr. Jeanne Serb who will talk about her research in adaptation and evolution. We hope to see you then. As always, remember that resources and curriculum materials can be

found on our website, and we'll post the link and a QR code to that here in just a second. So, thanks for joining us for our third episode. Have a good day.