Transcript

Speaker 1: You're tuned in to 90.7 FM, k a l x Berkeley. My name is Tesla Munson and this is the graduates, the interview talk show where I speak with UC Berkeley graduate students about their work here on campus and around the world. Today I'm joined by Structural Biologists, Nicole Hal Ipec from the department of Molecular and cell biology here on campus. Welcome Nicole. [inaudible] you don't have to say I. It's a, eventually you will have to talk into the microphone. Okay. Well we'll start with the big question. Uh, and we talked about this already, but [00:00:30] so what is structural biology?

Speaker 2: Instructional biology, we're thinking about the molecules in the cell and in the body and how the shapes of those molecules actually affect their function and how they work.

Speaker 1: So when you say shape of a molecule, what gives a molecule like a shape? Is it just the different parts and the orientation they're attached to? I mean, I, this is like way out of my, this is like back to high school for me, but I don't,

Speaker 2: I never [00:01:00] really thought about the question of what gives a molecule its shape. And I feel like I could answer that in so many ways. So every molecule is made up of different atoms linked together. Um, and so the angles between those atoms and how far apart they are from each other dictates the shape of that molecule. And in structural biology, we're mainly looking at very, very big molecules with thousands and thousands of Adam's. So the number of possible shapes is actually huge.

Speaker 1: So what would be the exact, an example of like a really big [00:01:30] molecule? Oxygen is just oh two, right? So it's just the two. So it's small. That's a small molecule. So what's the Big One?

Speaker 2: Uh, anything that we study would basically be big. Like I study proteins specifically and the protein complex that I study is actually a whole bunch of different proteins linked together. It's thousands and thousands of Adams.

Speaker 1: So that's a really big one. But like nothing we would know by name, just like

Speaker 2: one large molecule that people might think about is hemoglobin, the protein [00:02:00] in the blood that actually ferries oxygen to the cells. So that's, that's an example of a protein. It's a biomolecule and it's fairly large. I studied proteins that are actually even bigger than that, but,

Speaker 1: and how can you tell how big a molecule is? Do you have to like bounce something off of it or how do you, how do people do that? There are a lot for a lot of ways. How do you guys do that?

Speaker 2: Basically in my lab we start with things that have already been characterized in terms of what atoms are in there and [00:02:30] how large they are. And we're just looking at the, the shape of that and how those atoms are oriented relative to each other. So we already know the size.

Speaker 1: Okay. Well I have to ask how, I mean not, not very many little children are thinking to themselves like, oh, structural biology, that's, that's the place for me. So how did you get interested in this or where did your interest start? Uh,

Speaker 2: I guess I always wanted to do science ever since I figured out, uh, what science was. My interest in it, in science in general started [00:03:00] when I was a kid. Maybe it helped that my parents are also interested in science. They never pushed me to do it, but a lot of the toys that I had as a kid were magnets and little prisms that I would look through. And I don't know if that's weird, but that was what was interesting to me to play with. Um, and I liked to read a lot. So as I sort of took classes and did reading online, I figured out that I liked biology and I liked chemistry. And the one thing [00:03:30] that really struck me was that sometime in, in middle school or high school, I realized that the cell is full of all these different molecules that have to do things.

Speaker 2: They have to get things actually accomplished, but molecules don't think right. So sometimes I don't even know what I'm going to do. How to molecules know what they're going to do and how do they all operate together in this big complex thing like the cell or even the multitude of cells that make up the human body. So that's when I figured that this was something that I could actually study [00:04:00] and do. For my career career. Yeah. No. And so then you did study that as you studied chemistry as an undergraduate, right? Oh yeah. I was a biochemistry major at the time. I guess a lot of the things that our inter was interested in were chemistry. I worked in a physical chemistry lab. So what in terms of like the difference between chemistry and biology, like when you say you worked in a physical chemistry labs, I mean you were just like putting tinctures into different test tubes and you know, heating them up like we see you with mad scientists [00:04:30] and in the movies actually a physical chemistry is probably about as far from doing what people would think of as chemistry as is possible.

Speaker 2: My goal in the physical chemistry lab that I worked in, Eric [inaudible] lab at Temple University was to develop a sensor for dangerous gases. Um, specifically the one I was trying to be able to detect was hydrazine, which is used as a rocket fuel. Um, so not only is it extremely explosive, it's also really toxic and so people need to know when this is leaking. [00:05:00] Have there been instances of this leaking, like in the past that that causes concern? Uh, it must be a concern somewhere, not just at NASA, but actually it was a collaboration with NASA. Oh really? Okay. So maybe it is like a NASA concern that they're just like, we just need to make sure that when we're developing these rocket fuels, like nobody's getting suppose to them. Yeah. Nobody is going to get poisoned or blown up. That was the goal. So when you work with them, does that mean you have to wear like a special suit or something if they're toxic and explosive [00:05:30] or they just ask you to put on a hairnet and put some gloves on? There are different kinds of precautions that you can take when working with these kinds of chemicals, um, depending on the concentration of them and what you're gonna do with them. So we, we basically have, um, or had a special setup in the laboratory that would ensure that none of the, the fumes would come into contact with us. That sounds pretty good.

Speaker 1: So you know, you feel pretty safe that you did not [00:06:00] ingest. A lot of hydrazine. That's what it is. Right. You feel mostly comfortable? Well, I definitely didn't get a blown up and I think that if, uh, I had been exposed, I, I would have noticed, so I'm, I'm probably fine. Um, that's pretty cool. And so did you actually like meet NASA scientists or this just a collaboration like over email sort of thing? We skyped. I'm just kidding. That's good. Did they wear like a NASA symbol? Did you actually [00:06:30] get to see any part of NASA or is just a, that's another project? Not really. Okay. So Bachelors of Science in Biochemistry at Temple and then, but now you're in molecular and cell biology, which is technically like a different thing. Right. So how'd you decide to make that transition or was it just like a natural progression from one to the other?

Speaker 2: So, uh, the molecular and Cell Biology Department at Berkeley actually has a lot of different subdivisions and the subdivision that I'm in is biochemistry, biophysics, and structural [00:07:00] biology. So, although my research is different now than what it was when I was an undergraduate, a lot of the ways of thinking and the, um, the topics are very similar.

Speaker 1: Yeah. So it almost has the same name actually then your subdivision, right. So maybe it wasn't so much of a transition, but um, where, remind me where his temple was that is on the east coast. It's in Philadelphia. It's in Philadelphia. Are you from Philadelphia? Somewhat. I guess

Speaker 2: I was born in Wisconsin and then my family lived in New Jersey for several years before I went to temple

Speaker 1: [00:07:30] in Wisconsin's like, I'm so bad at geography. That's like Midwest, not where it's more Midwest than east coast. Yeah, it's considered the Midwest. It's pretty far north by the great lakes touching Canada. Either way. The point is California is pretty far away from all three of those places. So was it just the school that brought you here or what were you thinking about other parts of California? It was really just a school. In fact, I had

Speaker 2: never even been to California before. I went on my interviews for Grad School and somehow I ended up going to interviews [00:08:00] at three different schools in California. So I chose to come here because of the school, but I don't regret my decision in terms of flipping shear.

Speaker 1: Yeah, no. And Yeah, go, go bears UC Berkeley. Yeah. All the way. Um, so, okay. So you came from the east coast pretty much the same topic, but obviously a new journey here. So what have you been interested in here at Berkeley? Like what are you working on these days? In my research, yeah. Or in life. We get in whatever, you know, [00:08:30] I know that some scientists do have lives, not, not very many, but a few. But, um, yeah, mostly research, like [inaudible]

Speaker 2: my current research is, can grow with my previous interests, um, and the molecules in the cell and how they behave. But one thing that's a little bit different that if you told me that I would be doing this a few years ago, uh, is that I'm actually studying something that's involved in the immune and the immune system always seems too complicated to me. Uh, this is the side of biology that [00:09:00] I'd never really went to. Like I was much more interested in the small things, the molecules and maybe the, the biggest thing that I might think about would be a single cell. I'm not thinking about the whole organism, like an entire animal or how does it develop and how, how does its immune system work? I, I never really, not that I'd never thought about those things, but I definitely didn't imagine myself working on that. So now when I actually ended up studying is this complex of multiple different proteins put together within animal cells that detects when bacteria [00:09:30] are present, when they're infecting the cell. And so what it does is that, uh, after it detects the presence of bacteria, it instructs the cell to self destruct and to, uh, secrete chemicals that cause inflammation.

Speaker 1: So is this process that we're thinking about about inflammation in these bacteria, is that like happening at a wide-scale and that there are many different kinds of bacteria that can come in and many like what we would associate with, like diseases can come in or is it very like one specific disease you're thinking about?

Speaker 2: [00:10:00] Right. Okay. So the, there are multiple different kinds of inflamma zooms, the complex that I study, but the one similarity is that they all are part of what's called the innate immune system. Uh, which basically means that they're responding to generalized threats. They're not the part of the immune system that says, Oh hey, I've, I recognize this, I've seen it before, which is called the adaptive immune system. What they actually do is detect pieces of intruders that are very, very common. So that the Inflammatone [00:10:30] that I actually study detects Flagellin, which is a protein in the bacterial flagellum, that little tail that helps it move around. So a lot of bacteria have flagella. So that's a really common thing that would be helpful to be responding to.

Speaker 1: So then this could, this reaction could be happening on a daily basis in humans, for example. Yeah. Yeah. So lots of, okay, cool. So you said you're studying the way that they react to the bacteria and, and release these other and self-destruct like the whole process or one specific [00:11:00] aspect of that.

Speaker 2: So what I'm studying is how the inflamma zone actually binds to that bacterial protein. So they come together somehow and then that must do something to [inaudible] that then lets it have these downstream effects that lets it give the signal for the cell to do those things. What I'm looking for is what happens to the inflamma zone when it's a textable gel and when flagellin binds the Inflammatone, there must be something that's happening to it that allows it to then activate this whole signaling cascade that says [00:11:30] you need to self destruct. There's some intruder here and, and bring on the inflammatory or sorry. And basically to summon an immune response to that site.

Speaker 1: So this takes us back to why you're actually a structural biologist, right? Cause you're talking about the structure of the bacteria and the structure of the inflamma zone and how they come together to cause this reaction. So physically like the physical property of joining.

Speaker 2: So yeah, there is a specific interaction between those proteins, but we don't actually know what it looks like [00:12:00] at that interface. We don't know how the Flagellin is en is interacting with the inflamma zone. And that's what we're actually trying to, that's part of what we're trying to find out because I mean the Flagellin has a specific shape and the proteins that make up the Inflammatone, they also have a specific shape. So which parts of the inflamma zone are interacting with which parts of the Flagellin. And if you know that, then you can figure out a lot about, um, [00:12:30] and so this is interesting just from a basic perspective of, um, how did these things work in biology? Uh, but hypothetically, if you knew that information, how, how these things bind together, then it's feasible that the information that we could gain from this research might actually also have some sort of medical implications down the line.

Speaker 1: If you're just tuning in, you're listening to 90.7 FM, k alx Berkeley, and my name is Tesla Monson. And today I'm joined by Nicole [inaudible] from [00:13:00] the department of Molecular and cell biology here at Berkeley telling us about her work in structural biology and looking at DNA immune system. So what are some of the methods that you guys use to try and answer these questions about how they're binding or what the structure is?

Speaker 2: In our lab, the main method that we use is electron microscopy. These protein complexes, even though I said that they are large, they're large on a molecular scale, there are large compared to many of the other molecules that you might be familiar [00:13:30] with, but they're actually still very, very small. Their size is usually on the order of maybe tens of Danta meters and Nano means small. We know that. Yeah, it's a, a nanometer is a billionth of a meter. Oh, okay. So very, very small. And you can't actually even see them with conventional microscopes, like light microscopes that you would usually picture in a lab or that

Speaker 1: like people like I used in high school or here at an in anatomy. Yes. Just like a general microscope.

Speaker 2: So the electron microscope actually allows [00:14:00] us to see even smaller things than the white microscope. So, um, that's why we use that to look at these complexes.

Speaker 1: And is it like, can you draw me a picture of it? Is it like a giant box or is it just like a normal, like the same size as like blight microscope or does much, much bigger as much as to be built into the room. Oh, okay. So very, very big. And you have one in your lab or do you have to go somewhere special to use it? Our lab actually has three electron microscopes farm or maybe two and a half cause one is shared. Nice. Okay. So [00:14:30] you must have a lot of rooms then you got to be built in, right? Yeah. Um, cool. Okay. So you use electron microscopy to look at this and that, is that it or is that like every day you just sit in front of the electron microscope and uh, fortunately not cause it's really, really dark down there to

Speaker 2: be in the basement so that the fibrations won't disturb imaging and also, um, yeah, it's dark. So it would get kind of weird and lonely if I was just on the microscope every single day. So that's [00:15:00] what, that's part of what we have to do. And the other aspects of it are basically on the, on the pre microscope side, you have to prepare that protein complex so that you can look at it under the microscope after you take your sample to the microscope. That's actually where most of the work begins with the electron microscope. You actually looking at, um, how the electrons passed all the way through your sample. So it's not exactly like a photograph. Uh, it's actually a projection. So [00:15:30] you have these images of your molecule, but if you really want to see the shape and how things are interacting, then you need to figure out what this looks like in three dimensions. You'll have images of the complex at multiple different angles, but that's still only giving you, uh, as sort of a two d idea of what this looks like. And we actually want to see it in three dimensions so we can see the entire shape of the molecules and how they're actually interacting most of the time then is actually spent in front of the computer trying to process that and trying to get [00:16:00] the, the 3d information out of that.

Speaker 1: So how long does the entire process take from like preparing a sample to getting in the microscope to assembling it? That is a good question. Like a day. Probably more than that.

Speaker 2: Yeah. So it can be pretty painstaking sometimes to find the exact right conditions for a, the complex that you're looking at to be suitable to be viewed under the microscope. And some things work out faster than others. You can make your um, samples to look at under the microscope [00:16:30] in a few hours or in a day. You have to do this many times to figure out the perfect conditions. And then when you're, when you're actually on the microscope for, for a very high resolution three d structure, we usually collect data for a very, very long time. The last data collection session that I had was actually seven days straight,

Speaker 1: but you didn't have to be there the whole time. Did you, you get to go home, right? Luckily

Speaker 2: in this case I had sent my samples to um, ev remote data collection site, but I have [00:17:00] collected data here, not for seven days straight and yeah, you do, you stay overnight, you hang out on the, the couch in the basement and

Speaker 1: just like waiting for the machine to beep. Um, so it needs a little,

Speaker 2: a bit of monitoring. You need to select where you want to take the images and you need to constantly, well not constantly, but every couple hours you need to fill up the liquid nitrogen that keeps it cold. So you can't actually leave it. You have to to babysit it. And

Speaker 1: [00:17:30] do you have an entirely left toxic substances behind if you're working with liquid nitrogen? Huh? Do you actually have to like pick up a tank and pour it into another tank and try not to melt your face off? I'm sure it's much safer than that. Here at Berkeley we wear goggles.

Speaker 2: Maybe I'm just too sensitized to it, but I don't find liquid nitrogen to be extremely dangerous. The main issues are if you're in an enclosed room, you could potentially be asphyxiated if it filled up with liquid nitrogen. But, [00:18:00] but that doesn't happen and it's also because it's so cold. If you get it trapped against your skin, then it can give you essentially frostbite. So it's dangerous to get it, especially in your eyes or something like that. But

Speaker 1: you can't, you can't do like they do in the movies where you're like if someone dips their hand in it, they could just shatter it into ice. Is that, does that fall, is that factor fiction? So I guess if you left your hand in there for [inaudible]

Speaker 2: quite a while, that might happen. You'd need a lot of liquid nitrogen. [00:18:30] So the thing is liquid nitrogen, although it's extremely cold, it doesn't absorb heat from the surroundings very easily. So, uh, it will take, it will take quite awhile and a lot of liquid nitrogen to to freeze your whole hand I guess.

Speaker 1: Okay, that's good to know. I feel better already. And you said that each like protein complex you're working on has like a different recipe basically and that every time you prepare a sample for a different complex, it's like a whole new scenario.

Speaker 2: Yeah, there are some basic principles and you can make predictions based on [00:19:00] things that have worked for similar complexes. But um, each time it's a little bit different and it's always different in each person's hands.

Speaker 1: So. Well it sounds pretty exciting overall, right? Big microscopes, liquid nitrogen, dark rooms. You have flashing lights, like maybe a few like lasers on the ceiling or not. Nothing that exciting. A disco ball, disco ball. Nice. Yeah, that counts. That counts. Well, so I, you've also done a lot of other work here at Berkeley with outreach, right? I saw, I saw that, that [00:19:30] you've been involved in quite a few different programs. So are any of those closer to your heart and you work more with one outreach program than another or are you just, um, try and do outreach wherever you can?

Speaker 2: This is also something that I never would have predicted if you told me, um, a few years ago that I'd be doing because a couple of the outreach programs that I'm involved with are actually involving middle school kids. And I, I didn't think that I liked children when it comes to science, it's actually really great to see how they react when it's presented [00:20:00] in sort of an interactive way and it's in, it can be made fun. Um, so it's not just they're sitting there and we teach them about chemistry and all that, but some kids are just naturally excited when they're reading about science or when their teacher is talking about science. But I think a lot of them aren't. And Science just seems like this collection of miscellaneous facts that you either know or you don't know. But the programs that I'm involved with, uh, one of them is be a scientist, which is essentially like a graduate [00:20:30] student led in class science fair.

Speaker 2: If you could imagine that. Um, and we, we work with small groups of middle-schoolers to have them develop their own idea for a science project to do so everybody can do something different. And of course there is a budget, but we bring a lot of the for them so that they can do something that maybe they wouldn't be able to do at home. And we go through the entire process of science with them. We allow them to make up their own hypothesis and we try to teach them about all [00:21:00] the variables that could be involved and get them thinking in a scientific way. And so a lot of them, when we first come in, they may not seem very interested. They're like, Oh man, we have to do this. But almost all of the students that I've worked with so far and that program, by the end, they seem to interested and excited about their own projects and about the other projects going on in the class.

Speaker 1: That's really great. Uh, it's, yeah, it's really great to see people, especially scientists here. I mean we're so busy, right. But finding time to actually try [00:21:30] and interest the next generation and make sure that they understand, as you said, scientific thinking and being able to think about a problem and then being able to complete a process all the way through and come up with some results. So that's great. And what inspired you to do this?

Speaker 2: In retrospect? I am not actually sure how I got involved in all these different outreach programs. I think that once I sort of started, then it just snowballed into this gigantic uncontrollable thing. [inaudible]

Speaker 1: [00:22:00] oh well I think it's good work. So I, you know, I think everyone appreciates it, especially the kids. But um, so speaking of kids, if, so, if you, do you have any advice for like younger generations of students who are interested in science who are thinking about either majoring in science in college or trying to get involved in a research lab? Do you have any advice for them?

Speaker 2: So I would say that if you're interested in it, you should pursue it. Because even if you decide later on that maybe you know, you majored in physics and physics isn't for you, then [00:22:30] along the way you're going to learn a lot of things. Um, you're going to learn the scientific way of thinking and analyzing a problem and that's helpful no matter what you do. And for somebody who's an undergraduate and it's thinking maybe they'd like to get involved in research, I would say, um, if your school doesn't have a specific program for this, which they very well may, but if they don't, then try talking to some of the professors in your school and see if there are any labs that might have an opening because this is going to give you a much a better idea of how science actually works. [00:23:00] I actually was worried that I didn't really like science when I took, um, my intro chemistry lab because I didn't like all these sort of prescribed experiments where they tell you what to do. But then when I started working in a research lab and it's a lot more flexible, it's a lot more creative. You get to think of your own ideas and obviously there are standard protocols, there are way, ways of doing things, but it's a lot more intellectually stimulating when you're actually thinking about a problem that, that someone else hasn't solved already.

Speaker 1: [00:23:30] Yeah. I, it's cool to hear people use the word creative and science in the same or research in the same sentence because a lot of people, yeah, like you said, they think about science and they just think it's like a collection of facts and they don't really understand that there's this whole other aspect of creativity, even artistry that goes into being a scientist. So that's, that's cool. Good advice for students. Um, what about for the general public? Is there anything you've been like trying to get off your chest in terms of topics in your scientific field [00:24:00] or research or anything that the public should know listening to this radio show? Like science is good. I think we can agree on that one.

Speaker 2: I was interested in science from a very young age and um, I don't necessarily expect that everybody is going to say, oh, this is my favorite subject. I, I read chemistry journals for fun on a Sunday morning. But as I was saying, I think that the scientific way of thinking is something really important. Mastering the scientific way of thinking is really important for everybody. You can use it in your daily life to, for example, evaluate claims made [00:24:30] by politicians or determining whether you really should mix those two household chemicals together. If it's dangerous. I mean all these kinds of things don't necessarily require you to get a phd, but just to sort of be trained to, to think in that way. It's like a sport where some people might come into it with a little bit more talent than others, but you're never going to be good if you don't actually do your practice. So, so having a basic education in science is really important for everybody, I think. Yeah.

Speaker 1: Yeah. No, I think that's great. And that's definitely a message that we're trying to promote [00:25:00] here at Berkeley and also on the graduates. So I think we're about time for a last words. Now's your chance. If you have any last words about anything we said you can throw them in now, otherwise we're going to call it.

Speaker 2: I guess to me one of the most important things is not just that I think, um, scientific education is important, but all this research doesn't come out of nowhere. It costs a lot of money actually. And the public funding for scientific research has kind of been dwindling a lot over the years. [00:25:30] And I think, I mean, part of that is due to the economy, but a lot of it is that maybe the benefit to society of a given research project might not necessarily be apparent right away. And so I could just tell people that I study this because I'm interested in it and I like it. And I think other people should be interested in it too. But when it comes to actually spending federal dollars on this, uh, why should people care? And I would just say, we don't know what's gonna come out if something, until we start studying it.

Speaker 2: A lot [00:26:00] of the great findings in biology, for example, in this century has been made in flies. Even as someone in basic science, I can't say that I would have anticipated that all these amazing results in biology that are so important and fundamental now a would have come from researching fruit flies. So in science funding, this kind of stuff, all kinds of science is actually, uh, not just a curiosity. It's really important for society as a whole. And even though it might just be I'm a fruit fly for example, that doesn't mean that [00:26:30] it's not important.

Speaker 1: No, I think that's, that is definitely a great point, especially as you said in today's, you know, in today's world where the funding seems to be harder and harder to come by, we can't emphasize enough that even if it's basic science as you said, which is just like trying to understand things or if it's applied science where they're actually trying to make it, uh, make the world a better place. For example, using research either way, 100%, we can agree that it's really important [00:27:00] and you're not going to know what comes out of it until you actually sit down and do the research and see what's there. So, um, I think that's a great point and I hope that everyone out there is listening and taking note of that and maybe voting to increase science funding. Yes. Yay. Um, so I think we'll leave it there cause now we set our last words, so thank you for listening.

Speaker 1: My name is Tesla Monson. You have been tuned into the graduates here on KLX Berkeley. Today I've been joined by a structural [00:27:30] biologist, Nicole Hal Ipec from the department of Molecular and cell biology. She's been telling us about her work here at Berkeley and also in the past at temple where she got her bachelor's science working with toxic substances. But now moving on to the innate immune system and just trying to understand the basic science of immunity in animals, including humans. So obviously really important at the basic level and also really applicable to our everyday life. So I think it's a great topic [00:28:00] and I want to thank you again for coming on the show today and we'll be back in two weeks with another episode. Until then, stay tuned. You're listening to 90.7 FM k a l ex Berkeley.