Getting Curious with Jonathan Van Ness & Kathleen Johnson

JVN // [SINGING] Highway to the danger zone. Ah! Ah! Welcome back to Getting Curious. I'm Jonathan. Every week I sit down for a gorgeous conversation with a brilliant expert to learn all about something that makes me curious. Grab your helmet and grab a headlamp because this week we are going spelunking deep inside the world of caves and honey, they are dangerous and gorgeous. Welcome to the show, Kathleen R. Johnson who is a Professor of Earth System Science at University of California, Irvine's School of Physical Sciences. Professor Johnson studies modern cave systems to assess past climate patterns and to predict our earth's future. Professor Johnson, how are you today?

KATHLEEN JOHNSON // I'm wonderful. I'm so excited to be here.

JVN // You guys, this is one of the times when I lament podcasting only because you should really see Kathleen's power fringe and gorgeous face. I just love a well-placed power fringe and yours is soaring with, like, flying colors. A+, no notes.

KATHLEEN JOHNSON // Thank you so much. I am very glad to hear that from you, especially because I trim it myself.

JVN // You do?!

KATHLEEN JOHNSON // Yes. If you look closer, I'm sure you could tell.

JVN // No, you're a literal professor. I know that you can slay a fringe trim. It's not your fault that you're multidimensional. You know what I'm saying? Okay, wait, I am literally from across the river from the Mark Twain caves.

KATHLEEN JOHNSON // Amazing.

JVN // Have you ever heard of those?

KATHLEEN JOHNSON // I've heard of them. Yes, I've not been.

JVN // Yeah, yeah I've been in them! It's, like, where you go on your first field trip in first grade. So like I go way back with caves just so, you know, like, me and caves, we go way back.

KATHLEEN JOHNSON // Awesome.

JVN // But let's start on the surface. Excuse the pun.

KATHLEEN JOHNSON // Okay!

JVN // What's a cave?

KATHLEEN JOHNSON // One of the first definitions I heard about of a cave is that a cave is a natural cavity in rock big enough for a person to go inside of it. So there's solution caves which are formed when the bedrock actually is dissolving and leaving these holes underground. And that's the most common type of cave, and the type of cave that I work in. But you can also have other types, like lava tubes or ice caves. There's also sea caves which are often formed where waves are crashing into cliffs along the ocean. So those tend to be a bit smaller.

JVN // Do they exist everywhere? Like, in every continent?

KATHLEEN JOHNSON // They do, pretty much. If you're thinking broadly about caves, they're found anywhere where you have the right rock type, which in most cases is limestone. And there's ice caves, for example, in Antarctica. I don't actually know whether there are solution caves there but every other continent has caves.

JVN // Do they tend to be, like, more common in more mountainous regions or like hillier regions or is there ever just, like, a random cave in, like, a really flat ass place? And there's just, like, a hole in the ground and there's just like this random cave?

KATHLEEN JOHNSON // I think you're more likely to often find them in, in a little bit more mountainous regions, but you can absolutely find one just on a relatively flat surface. It really depends on sort of the geology. If you have limestone, that's like flat lying, you very well can get a cave in what looks like there should be nothing there. And sometimes the caves actually, you know, as the mountains are forming and moving up, the caves can go up with them. And so actually some people have used the age of deposits in caves to try and understand, like, the timing of past tectonic events like mountain building. So that's a whole separate field that I'm not an expert in, but it's pretty cool.

JVN // That's really cool. Okay, wait, what's, like, the Nile of caves?

KATHLEEN JOHNSON // There's actually, like, some debate about this between the different caving groups, right? Like, what's the right measure for what makes the biggest cave? So there's different caves that claim to be the biggest in different ways. So Mammoth cave, which is a national park here in the US is actually the longest cave in terms of passage length. It has over 400 miles of passages that have been mapped and they're not done mapping it yet. Like, there's still more to be discovered.

JVN // Dang!

KATHLEEN JOHNSON // Most of the caves, like, I work in that we'll talk about are, like, maybe a couple of kilometers long, at most.

JVN // But then is there, like, 3D-ness to it, too? Like, is there depth as well? Like, how deep it goes?

KATHLEEN JOHNSON // Yeah. So how deep they go can vary quite a bit. And I was reading about this recently and the deepest freshwater cave they just discovered that it's much deeper than they thought it was. And it is about a kilometer deep.

JVN // Dang.

KATHLEEN JOHNSON // So that's quite far underground to get down into that. The deepest ones I've been in are more, like, maybe 100 or 200 meters, at most.

JVN // Is the difference between a mine in a cave that, like, a mine is man-made or something?

KATHLEEN JOHNSON // Yeah, exactly. So mines are, are cavities drilled out of rocks that are done by humans.

JVN // Do they ever do, like, mines *in* a cave?

KATHLEEN JOHNSON // There's often quarries but not so much mines.

JVN // Oooh!

KATHLEEN JOHNSON // So, so quarries because limestone is used in the making of concrete and all sorts of other things in industry. You find quarries where they're mining the limestone basically, but it's not, like, inside the cave, usually. In fact, often those activities destroy a lot of caves.

JVN // Ohhh!

KATHLEEN JOHNSON // Yeah. Which is not great always.

JVN // Boo, don’t fuck with the quarries!

KATHLEEN JOHNSON // Yeah. And then caves can also be formed in salt and in some of those caves you might find them having been used for salt mining.

JVN // Ok. So how do the caves form, honey? Like, I mean, I would imagine if it's a solution cave, doesn't like water just take, like, millions of years to make that big of tunnels? Or can it be faster?

KATHLEEN JOHNSON // Yeah, I mean, it can be relatively fast in terms of geologic time, like, as a geologist, we think of time a little differently sometimes. So millions of years even can seem relatively young. But, but the way that they form is through slightly acidic water. So when rain falls out of the atmosphere, it already has a slight acidity to it. So its pH is less than seven, if you remember back to your chemistry classes. And then what happens when it hits the ground and infiltrates into the soil. In the soil, there's actually a lot of carbon dioxide there and that carbon dioxide is coming from the decomposition of organic matter like plant matter. And also roots themselves can respire and emit CO_2. So you can have much, much higher concentrations of carbon dioxide in the soil than you do in the atmosphere. And so when that water reacts with that soil, it forms a carbonic acid, the same type of acid you might get, if you were to, like, you know, drink a LaCroix or something like that.

JVN // Mmm, interest.

KATHLEEN JOHNSON // Yeah, it won't have that much CO_2 in it as—it's not fizzy.

JVN // Right.

KATHLEEN JOHNSON // But it does have a lot of carbonic acid, and that acid can really efficiently dissolve limestone, which is made of a mineral called calcite, which is calcium and carbonate. So, it's $CaCO_3$. And the water is moving along through fractures and the more it dissolves, the bigger those fractures get. But where most caves actually form is actually right around where the water table is, where you often can have, you know, quite corrosive water and you can have, like, a lot of it. So big cave passages often form underwater. So the ones we go in today, at one point, they were formed by running water either by streams or by tubes of water, basically. And that water flow typically will follow the patterns of jointing or fracturing in the bedrock. And so you can end up with these really, like, complicated three dimensional networks of caves where you have different levels. And then by the time we go in them, and by the time they start forming, like, stalagmites and, and other decorations, the water table has lowered relative to the cave. And so a lot of those things can only happen above the water.

JVN // And do caves ever come to a point where they're, like, mature and they, like, stop evolving and then they, like, collapse or something like, is there a life cycle to caves? Or are they always kind of moving?

KATHLEEN JOHNSON // Yeah, I mean, I think you can find evidence for ancient caves that no longer exist in some places called paleo karst. Karst is the name we use to describe these types of landscapes that are dominated by limestone and the solution process. But yeah, caves can change if the climate changes, if their geologic setting changes. So if there's, like, mountain uplift or things like that, they might become less active or they can change and go from a cave that is actively being formed by streams and water flowing underground to caves that are instead accumulating a lot of deposits of things like stalagmites. There's also, like, longer term, you can have caves that just become inactive because water stops flowing. So if you had, like, a major shift to dry conditions that can happen. So, like, there's these caves actually out in the Mojave Desert in California where it's extremely dry and they're pretty inactive. They might find water dripping in there on occasion when it rains there, but they're really not changing very rapidly now.

But at some point in the past, it was much wetter in that region and they, they were more actively forming. And then another cool example is people have recently been started using caves at higher latitudes in areas where you have permafrost where the ground is permanently frozen. And one of the concerns with climate change is how quickly and how stable this permafrost is. How is it going to thaw and what impact will that have on the carbon cycle and climate? And so one thing that you can do is study the extent of permafrost by, by looking in a cave and figuring out when in the past was water dripping down, which would mean there's no permafrost? Versus when was there nothing happening, which would mean it was covered with permafrost. So like there's studies in Siberia and higher in North America that are doing this. So there's all sorts of really cool things you can learn just from the presence of a cave and stalagmites growing in the cave.

JVN // Oh my God, I can't wait to learn more about stalagmites. Okay, wait. So how does, like, a massive cave withstand a partial or a total collapse?

KATHLEEN JOHNSON // Yeah. So essentially it's a battle between gravity—which of course is wanting things to fall down—and the strength of the rock. So you have these openings underground. The reason (like?) the land surface isn't automatically just collapsing every time is that the rock strength is enough to, to keep it up. But over time as that rock gets more and more weathered or maybe something else changes, maybe there's development on the top or there's, like, extra water that enters the surface that causes the weight of the overlying material to increase. You can get these sudden collapses that form sinkholes. And so in some places where you have a lot of this limestone, you'll find sinkholes and sinkholes—these types of sinkholes—are basically the collapse of a cave ceiling. And actually, like, some of the entrances to the caves that we go in and explore are effectively sinkholes. But then, you can go down into them and then follow them into parts of the cave passage that are still, still preserved.

JVN // What forms of, like, plant and animal life call caves their home. I feel like I know one right away—bats!

KATHLEEN JOHNSON // Yeah, that's usually the first thing people think of. And there's definitely a lot of bats. Actually, the caves that we are looking for for our work, we're trying to avoid the areas where bats are. Basically, they poop out stuff all over the stalagmites we want to measure and then it complicates our signal and they don't really like to grow in that environment. So because of the kind of unique environment that you find in caves, caves have little plant life, only near the entrances where you have light coming in is where you have most plant life. And so they're pretty low energy environments. So all of these, like, critters that are living in the cave, they have all of these special adaptations—like slow metabolism, so they don't require a lot of energy. So you can have eyeless fish, basically, because they can't see under there anyway. Some of these insects, apparently, have evolved these extra long legs and antennae. So they can kind of feel their way around and move around more efficiently, which makes them all the more horrifying. Imagine a centipede with, like, giant legs that's, like, scurrying around and caves actually have these incredibly unique ecosystems with a lot of endemic species. Those are species that are only found in a particular location. So each cave might have its own specific species of different types of fish or salamanders or huge spiders, centipede, snakes, cockroaches—

JVN // No! I was gonna ask about snakes. Do you see snakes, too?

KATHLEEN JOHNSON // Yes. So we have to be careful. The snakes tend to hang out around the entrances where they are hoping to get some, you know, bats to snack on, usually. And so usually when we go, we're, like, making enough noise and they get out of our way. So it's just, like, hiking around in California, you have to kind of be aware and make sure you don't step by the rattlesnake, right? So they're not that big of an issue, but I have seen vipers—

JVN // No! No!

KATHLEEN JOHNSON // —That can be pretty poisonous and I've also seen in Sri Lanka once. I was there in 2007. I actually accidentally stepped right over a cobra, which is the most terrifying.

JVN // A wild cobra?!

KATHLEEN JOHNSON // Yes, it was small. It was small. Like, I didn't go back to look at it carefully, the people behind me told me.

JVN // You are hard core, you're a hard core scientist, honey, out there in the cave. So, would you say that that was the scariest animal that you ever saw?

KATHLEEN JOHNSON // In terms of like, actually just startling. We've actually also seen two pythons in different caves and they are big.

JVN // Oh, jeez.

KATHLEEN JOHNSON // But they are not poisonous, right? They're constrictors. And so I wasn't that scared of them. I thought that was really cool to see them. But one of the ones that we saw was actually kind of hiding inside a, a little hole inside the cave in, in the wall. And one of my colleagues from Laos was trying to help us put a data logger in this little hole because we want to hide them so that people don't see them and steal them. And instead he tried to put this thing in the hole and the python just, like, came, like, striking out at him. It didn't bite him thankfully because it probably would have hurt even though it's not poisonous. So that was one of our frightening experiences.

JVN // That definitely qualifies, and I want to get into more. I like to go for scary things sometimes, I just can't help it. Have you ever been really scared in a cave? Like, have you ever been, like, "Oh fuck, like I hope this shit doesn't fucking collapse right now. Like if you guys ever had to, like, run for your fucking life." Like, have you ever just been, like, "God damn. Like, I'm just going to study these things outside a cave."

KATHLEEN JOHNSON // Yeah. I mean, I definitely find it scary sometimes. I feel like I've gotten definitely braver and, and more confident the more that I've done. But, like, I have had a couple of scary incidents in caves, like, one of them involved when I was just a graduate student, I went to China basically on my own for, like, months at a time, a few times when I was in graduate school. And we were way up in the mountains, like we had hiked up there and had to spend the night overnight in, like, a sheep farmer shack and, like, go to this cave. And actually my colleagues, while a few of us were in the cave doing our work, they were outside the cave and it was quite cold. So they built a, a fire, a bonfire. And what they didn't realize was that the smoke from the bonfire was, like, getting sucked into the cave. And so we're, like, way back in the cave and start smelling smoke and seeing it getting hazy and then starting to, like, realize, "Oh, this actually is not great." And so we ended up having to go out. But when we were leaving and getting closer and closer to the surface, the smoke was getting pretty thick, where we were, like, I was full on panicking, like, crawling the last, like, 15 meters and then, like, when we get out of the cave, you look behind you and look at the entrance and the smoke is just, like, pouring out of it. So, yeah.

JVN // Yeah, I would imagine. Shit. Any other super scary times?

KATHLEEN JOHNSON // I mean, one of the caves that we work in requires us to go down these really steep ladders and you can't really be tied in to a rope when you're going down these ladders. It's just, there's too many things going on. It's a little awkward and the ladders can be like, I don't know, 50, 60 meters high. So really, really high ladders that are in the dark. And so I don't actually feel in danger, necessarily, but I definitely don't like it.

JVN // Yeah, you just gotta, like, no fucking slips.

KATHLEEN JOHNSON // Yeah, you are holding on tight and, like, I've done it several times now and I feel more and more confident. Like, I'm not just going to spontaneously let go and like, you know, fall off.

JVN // I went to Playa del Carmen—my husband and I—a couple of years ago and there's, like, all those, like, kind of, like, underwater, like, caves that you can go down. And they were saying that those ones were, I think were from, like, that big asteroid that they took out the dinosaurs or whatever that hit, like, in the Yucatan Peninsula. They were saying it was from, like, fireballs. Like, do you know those caves?

KATHLEEN JOHNSON // I do. So, I've been to one cave there with a friend of mine who does research. There is a tourist cave called Rio Secreto, which is near Playa del Carmen. And, and there's also all of these cenotes—

JVN // Yes!

KATHLEEN JOHNSON // Which are these like, basically sinkholes filled with water and people go to, you can go to them and go swimming and they're really beautiful.

JVN // They're so pretty, such clear water.

KATHLEEN JOHNSON // Yeah, it’s kind of cold, though! When I was there, it was too cold to swim, really.

JVN // You got to go back. But you specialize in speleo—how do I say that word?

KATHLEEN JOHNSON // Speleothem.

JVN // Speleothem, speleothem! I'm obsessed. New word. $20 word. So you specialize in speleothems, and, specifically, stalagmites. So are stalactites speleothems, too?

KATHLEEN JOHNSON // They are. So stalactites are the ones that come down from the ceiling of a cave. Whereas stalagmites are the ones that grow up from the ground.

JVN // Yes!

KATHLEEN JOHNSON // And there's lots of other types of speleothems as well. So the broad definition of a speleothem is just any secondary mineral that forms in a cave.

JVN // Any secondary mineral that forms in a cave.

KATHLEEN JOHNSON // So, like, cool things called soda straws, which are, if you just have a single drip coming from the ceiling, you can basically precipitate calcite around the outside of that drip and it grows a little longer and it basically forms a literally looks like a straw and it has water flowing through the inside and eventually that will turn into a bigger stalactite, maybe. And then there's things called curtains or draperies, which are these very wavy, undulating, big bits of calcite that decorate the walls of parts of the caves. One of the special types of that that I really love is called cave bacon because it looks like bacon. It has different colored stripes and it has that same sort of waviness. And then there's cave pearls which look like pearls. Those are all speleothems.

JVN // And are they found, like, in all different areas of the cave or, like, do different speleothems more, like, tend to occur in, like, specific areas of caves?

KATHLEEN JOHNSON // They can be found all over in the cave. And the specific types you find might be different because it will depend on the cave environment. It will depend on how much water is dripping into the cave and things like that. But yeah, you can find them anywhere. They tend to cluster in certain areas where you have, you know, concentrated water flowing because that's one thing you do need to form a speleothem, generally, is water dripping into the cave.

JVN // So, okay, it's like, you know, it's like that show like the 1st 48, like, where it's, like, "You got 48 hours to, like, find someone's murderer." It's, like, because really, like, stalagmites have so much, like, evidence to give! Like, there's a lot, it's, like, it's almost like, not a murder scene but there's a lot of, like, evidence or something like, what can, like, scientists, like, find from, like, stalagmite. Like, what can they tell us about the past?

KATHLEEN JOHNSON // Yeah. Yeah. It really is a lot, like, solving a mystery or, or a puzzle because these stalagmites, they form in a cave. So, water is dripping into the cave and because of all that dissolving that's happened on the way down from the surface, there's loads of calcium in that water and carbon. And so when it enters the cave atmosphere, what happens is that carbon dioxide leaves the water and leaves behind this, like, little thin layer of calcite, the mineral. And over time as drips kind of stay in the same place for thousands of years. Over time, you can create these long stalagmites. So if you cut one of these open, you'll see lots of beautiful layers that are effectively like the pages of a book. The lowest layer is going to be the oldest and the, the very top will be the youngest. And one of the main reasons why these stalagmites are really useful for studying past environmental change, which is what we use them for is that we can actually figure out the age of each of those layers really, really accurately.

JVN // How!

KATHLEEN JOHNSON // So there's a method similar you may have heard of carbon dating before, which is using radioactive carbon 14 and how that decays.

JVN // Yes, I saw that date line when they tested the shroud of Jesus, honey in, like, 1997. Yes, I get down with a carbon dating moment.

KATHLEEN JOHNSON // So we do use carbon dating sometimes. But there's complications that make that a little bit of a challenge.

JVN // Yes!

KATHLEEN JOHNSON // But there's another method called uranium thorium dating. So we use uranium, very small amounts of uranium are included in these stalagmites, and it's radioactive and it decays to an element called thorium. And so by measuring the specific ratios of those different isotopes. So, isotopes are just different atoms that have different number of neutrons. So like we measure a couple of different isotopes of uranium and some isotopes of thorium, then we can do a lot of data analysis and calculations to determine the age.

JVN // Tell, like, how long it's been—because it isn't, like, radioactive stuff like the half life. It's like like it's like, you know what the half life is of that. So you could just tell how long it's been there in that state.

KATHLEEN JOHNSON // Yeah, effectively. So we, because we know the half life of the uranium parent isotopes as we call them, we can calculate the age. If we measure how much daughter has accumulated, we can measure the age pretty precisely. So that particular method works back to at least, like, 500,000 years ago. So we can date the sample along its length. And then we can, we measure lots of other markers along that same transect. And these things are called proxies. Proxies are any type of physical or chemical or biological signal that's preserved, like, in a natural formation that tells us something about the climate at the time that it formed. So people are maybe familiar with tree rings, how the thickness of a ring and a tree—

JVN // Yes! Yes!

KATHLEEN JOHNSON // Can tell you whether it was a wet year or a dry year in certain places or maybe a cold year or a warm year. In that example, like, the thickness of that tree ring is standing in as a proxy for temperature or for rainfall. So we can't actually go back in time and measure rainfall in the past. Unfortunately, but we can use these clues and the clues that we use in stalagmites are mostly chemical clues or geochemical clues. And so we use a lot of different types of isotope measurements. The most common one is oxygen. So oxygen has three isotopes, Oxygen, 16, 17, and 18, with Oxygen 16 being the most abundant one in, in most oxygen. We can use those really small variations in the ratio between those different isotopes in a stalagmite to actually tell us something about past climate at the time that that layer formed. And most commonly, those signals are interpreted as a way to study past changes in rainfall patterns, which is one thing that we really want to improve our understanding of what causes precipitation patterns to vary. In addition to using oxygen isotopes to study these sort of what we call hydroclimate history. We can also get all sorts of other information depending on what we're measuring. So we can learn about past temperature, past vegetation at the surface. We can even see things like volcanic eruptions sometimes or the impacts of humans on the environment.

JVN // And you could just tell that from testing, like, a *piece* of the stalactite?

KATHLEEN JOHNSON // Yeah, I actually have one here. Can I, can I show—

JVN // Show me, yeah!

KATHLEEN JOHNSON // So this is one of them, you can see the holes in here where we dated it, actually. And this one particular stalagmite is proof of continuously over the last, like, 37,000 years. So we take a really, really small micro drill and drill tiny samples along the entire thing. And then we can measure things, like, yeah, the trace elements in that, in that powder, we can measure these different isotopes of oxygen and also of carbon. And then there's other, newer techniques we're using like trying to study biomarkers or things that might tell us about microbial activity, things like that. Or we sometimes use methods where you can actually directly, like, stick the part of the stalagmite in an instrument and like shoot it with a laser to measure, to measure things a bit more quickly.

JVN // So that—the crime scene of the stalagmite, honey, can tell over the last—however old it is—can tell, like, how much water there was, if there was vegetation at that time, the permafrost thing, like, so if it was, like, cold. And then, like, that's about it, right? Like, temperature, presence of water, vegetation.

KATHLEEN JOHNSON // Yeah.

JVN // Okay, I'm obsessed. So, you've gone to caves in Laos, Vietnam, Mexico and beyond? Have you ever, like, studied caves in, like, Europe or, like South America?

KATHLEEN JOHNSON // Yeah. So, I mean, I, I've been to caves in other continents but really just as tourists, I did do a little bit of field work in Morocco, so North Africa. I've been visiting caves in different parts of, of Europe most recently in Romania in 2019.

JVN // Cool!

KATHLEEN JOHNSON // And I'm actually going to Brazil, Saturday tomorrow. Oh my God, I'm going to Brazil tomorrow and we're going to be going to some caves as well. So I, I'll have seen caves all over.

JVN // Come on! So what are some of the patterns that you've noticed? Like, do some tend to be more red or some are more gray or, like, not really? Like, have you noticed any patterns?

KATHLEEN JOHNSON // I wouldn't say, I mean, caves are pretty similar in, in different regions. The, the main thing is that the size of the caves and the number of caves is really gonna vary from place to place, depending on the specific type of bedrock and how thick those layers are. And also what the climate is like. But in general, if I was, like, inside any random cave, I would not be able to tell you, like, what continent I'm on. Would potentially be able to guess more if we were able to measure, like, a sample from a different cave and figure out where it came from, that would be more, more solvable, potentially.

JVN // Tell me more about that. Like what's distinct about the paleo climate records in each of these places that you've studied. Like, where you've actually, like, studied the stalagmites from.

KATHLEEN JOHNSON // Yeah, so a lot of my work is focused on like I mentioned China as well as Laos and Vietnam and all of these places are affected strongly by summer monsoon systems. So that's these, like, seasonal rains that come every kind of June, July and August. And that's when the bulk of precipitation occurs in most of the region. And so that Asian monsoon system is a really important part of the climate system that impacts over half the world's population. And there's still a lot of uncertainty about, like, how that's going to be impacted by climate change. And so one thing we will hope to do by studying in the past is improve our understanding of the different ways, the different mechanisms and timescales that monsoons can change under. One thing we found that's interesting is that this oxygen signal that I was talking about looks really similar all across that whole region, even though we know that the rainfall patterns, you know, there's quite a lot of regional variability in where, where it's raining and when. And so that oxygen signal gives us, like, this really great record of kind of large scale monsoon history. But we have to look at other things, things like carbon or different elements like magnesium that are recorded in the same stalagmites in order to learn about, like, that local rainfall change.

JVN // How can that information help you and other scientists, like, predict the future?

KATHLEEN JOHNSON // Yeah, the paleoclimate data for one then tells us, like, what's possible, how that climate system works. But also it provides actual data that is used to test climate models and these climate models are what we're using to predict future climate change and what the impacts are going to be in different regions. The thing about paleoclimate is we know that earth's climate changes naturally on a wide range of timescales, you know, we have interannual climate variability linked to things like El Nino, which is happening right now. We also have ice ages that, you know, happen over tens of thousands of years. And even longer term, we've had, like, bigger climate changes in the past. So, so if we want to really understand the complexity of the climate system, we need to have more information about past climate change than what we can get from the last couple of 100 years where humans have actually been measuring climate and recording it. And so the only way we can do this, then, is using these natural records, whether it's from stalagmites or also, like, ocean sediment cores or ice cores in Greenland or Antarctica. The, the data that we collect can tell us something about the kind of mechanisms or the dynamics that have caused climate to change in the past. And that might be in response to different factors, whether it's in response to greenhouse gas changes or in response to changes in Earth's orbit. Like, actually our orbit is what—those changes are what—cause, like, the ice ages. And they also cause a lot of variability in the Asian Monsoon system.

JVN // Is there something, once you test the stalagmites, it's, like, super different from, like, Mexican stalagmites to, like, a Vietnamese or a Chinese one?

KATHLEEN JOHNSON // Yeah, I mean, if we look at the ones from the Asian Monsoon region, over long time scales, they're really dominated by this 23,000 year cycle, which is driven by an orbital cycle. So we know the Earth's orbit, because of the gravitational pull of like the sun and the moon and other planets, it goes through these different cycles. And so one of those cycles is called, something called "precession." And it's basically where Earth's axis wobbles like a spinning top. So right now our axis that the Earth rotates on is pointed straight at the North Star. That's why the north star is always there in the same place. But in the past, just 11,000 years ago, it would have pointed in the complete opposite direction of the North Star because of this wobbliness of our axis. And so what that does is it changes how sunlight is distributed across the planet and it changes, like, the relative timing of the seasons. It has all these really complicated effects. But at a simple level, it leads to this 23,000 year cycle in how much solar radiation is reaching the Northern hemisphere, or actually anywhere on Earth. But when you have more heating over the land over Asia, that basically causes a strengthening of the monsoon system. And then when you have less heating, it causes a weakening. So you can see this extremely clear 23,000 year cycle in those records. Whereas in Mexico, the region we're working in is not affected by the monsoon. There, instead it's more affected by sea surface temperatures in the region which are linked to more things like the size of the ice sheets and the ocean circulation patterns in the Atlantic. Yeah, I'm probably getting into the, into the weeds.

JVN // No, that's so interesting. No, I'm, I'm no, I'm, that's so interesting! My TikTok showed me this story of this guy in Utah who, like, went caving but then he got stuck, like, upside down and he died after, like, three days and they, like, tried to save him. But then they had just like closed the cave because it was, like, so skinny and, like, tradge, and then obviously, like, those Thailand boys, they had to get saved and then, like, so, like, do we just need to like, keep our ass up out of fucking caves if you're not a scientist or something? Like, can you spelunk safely or is it just, like, what, like what do you need to bring with you or like should we just, it's like in a horror movie, like, "Don't run upstairs, bitch, run downstairs and get outside!" Just, like, don't go to the cave if you're not a fucking scientist or what?

KATHLEEN JOHNSON // Yeah. Yeah. So I would say that it's absolutely possible to go enter caves safely and be really safe and, and a lot of people have this as a hobby. It's not just scientists, but I guess in terms of like the appropriate way to go about doing that, you never would want to go into a cave that you don't know about on your own. Well, you never want to go caving alone anywhere, but also going to these caves with a group of people that know the cave or know the location. And, like, even better, you can start by just going to some tourist caves if it's something you think you're interested in doing. So there's a lot of tourist caves all across the US and other countries. The Mark Twain Cave, for example! People can find out, like, if they're on vacation or if there's caves near where they live and go check those out. But also there's caving clubs, it's really dorky. They're called grottos. So the, the grotto for the Southern California section of the, what's called the, is an organization called the NSS, which stands for National Speleological Society.

JVN // Damn!

KATHLEEN JOHNSON // So, so they have local chapters all over and those chapters like, organize cave trips, you can join them. Their cavers tend to be like, really interesting and welcoming and friendly groups. A lot of fun to go on those trips and you can, like, show up to a meeting and be like, "Hey, I want to like, learn how to cave, or can I go to a cave," and there will be people there that, you know, tell you what equipment you need to get, what training you might need to have. And there are opportunities for people often at all levels from like the very beginner stuff to like, you know, the really extreme stuff where you are, like, exploring new passages and sometimes even spending days underground.

JVN // Fuck that. But that sounds interesting if you're into it!

KATHLEEN JOHNSON // Yeah, I mean, I'm not actually, I'm into it for the science, but I'd rather—I don't know.

JVN // Honey, yeah! Scare, scare. So how do you navigate cave passageways? Like what do you bring down with you when you go to research?

KATHLEEN JOHNSON // Well, I mean, the basic equipment that everyone needs is a helmet and a headlamp and gloves are extremely important as well as just wearing clothing that you're prepared to get trashed and, like, really good hiking boots. But when we go to do our research, we also take a lot of specialized equipment, of course. So that can include things, like, actually for sampling the stalagmites, which we do just with a hammer and chisel. So that's pretty easy. But then some caves require special vertical caving gear to be able to repel or climb up a rope. And so that would include like an ascender, a descender and a harness that you have to wear. And then that's just to, like, get through the cave. And then our scientific equipment will include things like one of, one of the things that we do and this is really common in lots of other paleoclimate fields is we really want to understand clearly understand how the climate signal is being translated into these chemical signals that we're measuring in our samples. And so one way to do that is to really study the modern cave system. So the modern cave environment—what is the water chemistry today? How does that relate to climate today? And so we do a bunch of things like monitor the temperature and the humidity in the caves. We monitor how fast drip water is dripping at certain sites. We monitor the CO2 content of the cave air.

JVN // And so what are y'all finding with that? Are you, like, "Yeah, climate change is real bitches, like, we're fucked." Like, what are you guys finding with your research?

KATHLEEN JOHNSON // Yeah, so, like, one thing we want to know is, like, is the cave temperature constant or is the CO2 constant year round? Because if not that could have—

JVN // Is it?!

KATHLEEN JOHNSON // It depends!

JVN // Oh, fuck.

KATHLEEN JOHNSON // Most caves actually do have a really stable temperature. But as, like, the climate warms outside, they will also warm with the climate. So, like, the temperature in a cave usually is pretty close to the mean temperature at the surface. So you lose that seasonal variability and you just have this stable temperature, which is great for the signals that we want to record. The CO2 in the cave is actually not necessarily linked to kind of our carbon emissions, but it, it is related to how air is flowing in and out of the cave. So, like, all that drip water that's coming from the soil to the cave, a lot of that carbon dioxide then gets, is released from the water once the water enters the cave gets degassed. And so you can have accumulation of CO2 in caves. So that's actually one thing you have to be careful of if you're going into caves that you don't know because you can actually find extremely high and dangerous levels of carbon dioxide in the air.

JVN // Interest.

KATHLEEN JOHNSON // I've been in a cave that had something, like, 7000 parts per million. And for reference, the atmosphere is 420.

JVN // Oh, is that, like, pass out status? Like, do you need, like, a mask or something?

KATHLEEN JOHNSON // You start to feel like, "Why is everything so hard?" And honestly, I feel that way sometimes anyway in the cave, but this makes it worse.

JVN // Oh my God!

KATHLEEN JOHNSON // So, yeah, that's another thing. So, so yeah, we take that monitoring gear and then depending on the cave we're working in, in terms of how we're navigating through it. The ideal cave for our research is—are the easier ones to get into. So like if we can just walk through, that's awesome. But a lot of them, I already mentioned, some of them require climbing these really steep ladders up and down. There's also sometimes some kind of bouldering or vertical caving with a rope. Some caves do require crawling or squeezing through certain sections. And then also I've been in caves where there's parts where you have to swim or kayak through the cave. So, like, one of the caves that we've worked out in Laos is a pretty well known cave there called Xe Bang Fai cave.

And it's a really long cave that has a river flowing through it. And actually, we're, we're not working in that cave, specifically, but we have to go through it to get to the smaller cave that we're working in. And so it's six kilometers of kayaking kind of through this cave with several, several bits where you have to get out and carry the kayak over, like, some piles of rocks to get around some rapids, really fun. But it's kind of crazy kayaking, like, all day in the dark.

JVN // It sounds fun, but also kind of scary. And, like, yeah! So when you get in the cave and you're, like, "Ok, that's a good stalagmite, I want to sample that." Like, how, because, I mean, haven't some of them been there for, like, a kerjillion years? Like, how do you decide, like, which one you're gonna take?

KATHLEEN JOHNSON // Yeah, that's a great question. And they have been there a long time and like, that's one thing I always try and stress and is that we really want to make sure that these samples that we're collecting are, we know that they're going to be useful. We try to not take them from places where it's going to be really obvious. I mean, they're not alive but they do have aesthetic value. The scientific value is great so that, you know, it's necessary to take them at times. But we want to make sure we do our best to decide which samples to collect. And so some of the things that we look for are specific locations in the cave. We generally want them to be far away from the entrance so that the kind of environment is relatively stable. Often we want ones that are, like, far away from any rivers or streams because sometimes those might flood every year and deposit just dirt and mud all over them, which we want to avoid. And then, are they accessible, can we actually get to them without, you know, killing ourselves—also important. And then the, the shape and the size of them is something that's also really important. This one that I showed you, this is what we call a candle shaped stalagmite. It is really tall and skinny and those are indicative of, like, pretty slow and steady drips that haven't changed a lot over this entire time period. And so that's kind of the ideal. It doesn't mean that other stalagmites with other types of shapes aren't useful, but these ones are the best. So we look for those. And you might not find them in every cave. We can try our best to collect samples that are gonna be useful. There's never any guarantee. And one of the things is it's really hard to know the age of a sample before you get it and get it back to the lab.

JVN // Do stalagmites or stalagmites grow faster than one or the other?

KATHLEEN JOHNSON // I think stalagmites tend to grow much bigger than, than stalactites. Stalactites, if they get too big, they will just fall, they're forming in a much more complicated way as water is kind of flowing down the different sides of it at different times. So, yeah, I think it's probably safe to say that stalagmites form a bit faster in some of these caves in Southeast Asia. You can see these stalagmites that are, like, tens of meters high.

JVN // And then for stalag*mites*, do we know how fast they grow? Like, is it, like, one centimeter every 1000 years? Like, what's, like, the average that they grow?

KATHLEEN JOHNSON // Yeah. So it depends. The, the average for most of the samples we're working with is about, oh, gosh. Now, I might need my calculator. Hold on. I, I know that the answers off the top of my head in microns per year. So, somewhere between, like, 20 and 100 microns per year. So a millimeter might be 10 years, 10 to 50 years.

JVN // So, what about an inch?

KATHLEEN JOHNSON // Oh, oh no! Now I'm going to have to do more complicated math. Hold on, if that's all right.

KATHLEEN JOHNSON // Yeah, no, I'll hold, because I need to understand. I don't speak millimeters anyway. I wish I did, but I don't really get it.

KATHLEEN JOHNSON // Yeah. So an inch could be, like, something around 1000 years pretty easily.

JVN // Damn!

KATHLEEN JOHNSON // Yeah. But it, it, it does vary.

JVN // It just depends on how much water it is and what the climate is.

KATHLEEN JOHNSON // Yeah.

JVN // Got it.

KATHLEEN JOHNSON // The ones that we're working on, we prefer slightly slower growing ones so that we can look over long periods of time.

JVN // And then, so let's say that you join your local, like, what's those people called again? Like, your local cave people?

KATHLEEN JOHNSON // Our local cave people? Oh, the grottos, you mean?

JVN // Yes, the grottos! So what could you like, discover and like if you go and you like, want to go try caving and then you, like, join a grotto and then you go, like, what could you maybe discover in there?

KATHLEEN JOHNSON // Yeah. I mean, I, I think you could discover a lot. I mean, caves are really one of these areas that are still not fully explored. It's, like, caves and the deep ocean are probably some of the most unexplored areas on the planet. And so I think that's what motivates A lot of cavers is they want to be the first person to, like, get to a certain point. And those are the really extreme ones who are, like, pushing the limits of these known cave passages and trying to find more. But, like, for any person who enters a cave, it's always an adventure and, and there are so many different things to discover. Every speleothem is unique. Every cave passage is unique. Sometimes they're muddy, sometimes they're, like, sparkly white and just, like, amazing and they're really often super beautiful.

JVN // They are sparkly white?! What other, like, super fucking pretty ones have you seen that are just, like, really, like, pretty looking!

KATHLEEN JOHNSON // Yeah, just, like, a lot of decorations on the walls.

JVN // What about, like, a geode cave? Just, like, a big ass fucking geode.

KATHLEEN JOHNSON // The closest thing would be I don't know if you've seen these like massive crystals of gypsum in Mexico? In a really deep, it's actually in a, a really deep deep cave that's not very easy to get to, it's part of a mine actually. But there's these, like, it looks like kryptonite. It's, like, huge, huge, like truck-sized crystals of this mineral underground. That is very, very amazing. It's a place called Cueva de los cristales, in Mexico. I would love to go to that, but I don't think I would be allowed.

JVN // Oh my God. We got to Google it and find a picture. It seems like new caves are still being discovered today though, right? Like, people are discovering new caves all the time?

KATHLEEN JOHNSON // Yeah, yeah. I mean, that's definitely one of the things that the hardcore cavers do is they, like, will do these ridge walks. They'll just, like, walk around in the areas where they think there are likely to be caves and look for them. There's one cave in Sequoia National Park that I've done a little bit of research in which is called Ursa Minor Cave. And that cave was discovered based on, like, a tiny little softball-sized hole in the bedrock that people noted. And then they, they made the hole bigger and went inside and it turned out to be one of the most beautiful caves in the Western US. It is absolutely gorgeous. It's one of these very, very white and sparkly ones. So the National Park Service, of course, limits very much how many people get to go in there. And when you go in, you have to, like, bring a full change of clothes and, like, different shoes or, or go in your socks to like, avoid tracking mud through.

It's very, very tightly managed because it's in a, a wilderness area and it's in a protected area of the park. But, like, that cave was just found in 2006, I wanna say. And then actually one of the other caves that I, I was gonna mention earlier when you were asking about the biggest caves, there's this cave in Vietnam that's—we're working in Vietnam, very closely with the National Park there, which is also a UNESCO World Heritage site. And it's called Phong Nha-Ke Bang National Park. And that park is famous for this cave called Sơn Đoòng Cave. And Sơn Đoòng cave was only found by a local hunter in the jungle in 1990. And then he apparently told some people about it and then kept trying to find it again. And he could never found his way back until 2009 when he had a team of cavers with him and they explored the cave. Then in 2009, they, they did a complete survey of it and they found that that cave is officially the biggest cave in terms of the volume of the passage. So there are single rooms in there that are big enough that, like, you could fit entire city blocks of, like, the Manhattan skyline inside a room.

JVN // The cave cavities are, like, that big!

KATHLEEN JOHNSON // Yeah, it's amazing. I can share some pictures of that as well and you can go there as a tourist. So now there's a company that runs, like, kind of really great tourist to go to it. And there's like quite a long waiting list to get there. But that cave is actually just very, a very short distance away from one of the caves that we're doing a lot of research in. It's so big, it has its own, like, weather systems—it has, like, multiple near the entrances. There's effectively these giant rainforests growing in the cave. It's incredible.

JVN // Okay, Vietnam, cool caves! Is there any other, like, really recent caves? Like, does your Google alert come on when someone, like, finds a new cave?

KATHLEEN JOHNSON // I mean, I, I am part of Facebook group. So if there's, like, a big discovery, it'd probably, like, come my way. I'm not on Tiktok. So maybe I should start following the, the—-

JVN // You've gotta start CaveTok. You gotta start CaveTok. I bet it's already there. You gotta get there before it's too late. What mysteries remain about caves? Like, what do we still not know?

KATHLEEN JOHNSON // Oh, gosh, I think there's still a lot we don't know. I still think often we don't really know how old they are. We say that they're millions of years old but relatively recent, but some of them might be much older, potentially. It's just hard to date them sometimes and there's a lot of need for research on that. But also the extent of caves and how they are connected with each other in different regions is, is still not known. So there's a lot of unmapped passages, unknown connections. And then there's a lot of biology research that happens in caves as well because there's a lot of, you know, like I was saying, endemic species and new species that are discovered all the time in caves. So I've been in the field with some biologists who are, who are studying spider species and they've discovered several different spider species each in, like, different cave systems.

JVN // Have you ever seen some scary ass spiders? Because we talked about the snakes. Have you ever seen, like, scary ass spiders? Like, what crazy fuckers that you've seen?

KATHLEEN JOHNSON // Yeah, there's—so the spiders can be big. The biggest one I've seen was about the size of a frisbee with a body, the size of, like, kind of a large mouse. But routinely, we'd see, I mean, I can show you pictures if you'd like!

JVN // Yeah, I wanna see! What did they say the species was?

KATHLEEN JOHNSON // They're related to Huntsman spiders. Have you been to Australia?

JVN // I was gonna guess Huntsman, yes! Now, so with the whole climate change of it all, like, because I mean, a lot of what you study with the stalagmites is like, you know, we're looking for presence of water, we're looking for temperature, we're looking for permafrost, we're looking for like how climate change acts on, like, a much larger zoomed out way? Like, are you shitting your plants about climate change? Like, has what you found? Like, is it giving, Don't Look Up vibes. Is it bad?

KATHLEEN JOHNSON // Well, I mean, it's, it's really like what scientists have been saying is going to happen for, for many years now is, is really, we're starting to see a lot of that really happening. But I, I definitely don't think that there's no hope. If I, if I think about the paleo climate perspective, climate has changed a lot at different times. In the past, we've had climates that are warmer than today in, in geologic history. But the rate of change today and the magnitude is pretty unprecedented for quite a long time. So, like, the fact that these climate changes have happened over decades—

JVN // As opposed to thousands of years, or—

KATHLEEN JOHNSON // As opposed to thousands or even millions of years is what's what's really concerning.

JVN // That should raise the fucking alarm.

KATHLEEN JOHNSON // Yeah, it is unprecedented. It is scary. But there's also, I think a lot that can be done about it. I think there's a lot of innovation and technology and people who are really, really smart and working really, really hard to figure out, you know, how to minimize the impacts of climate change, how to adapt to it, how to adapt to it in a way that is equitable. That's one of the things I'm also really interested in is, you know, we know that climate change is impacting certain communities much more than others and will continue to do so. Of course, these are marginalized communities, communities of color often and low income communities. And so, like, one of the things that I'm really, like, encouraged by is the kind of growing recognition by scientists but also policymakers and, and government officials about the importance of making sure that environmental justice is a factor that's considered in how we are dealing with climate change. So, yeah, I think in terms of the things that we're seeing, yes, it's gonna be expensive and continue to get more expensive and more damaging, the longer, you know, we take to act to reduce emissions and figure out the best ways to remove carbon dioxide from the atmosphere.

JVN // Yes!

KATHLEEN JOHNSON // I just have to remain optimistic.

JVN // Yes, we're giving optimism. So Kathleen, what's next for your lab and for your work and how can we keep up with you?

KATHLEEN JOHNSON // Well, I mentioned a couple of things. I'm headed to Brazil tomorrow to teach in the summer school, actually, about speleothems to graduate students from all over the world. So I'm pretty excited about that, but like longer term in terms of my paleoclimate research, we're, we're aiming to continue our work in Southeast Asia and Mexico for a long time. One of the things that I'm really valuing and focused on is making sure that we are building, like, strong and reciprocal relationships with community partners and scientists in these countries that we're working in. And so, like, as one example, last year, after, like, several years of negotiating and building relationships, we signed a memorandum of understanding, like, a formal document with this National Park in Vietnam that, that paves the way for us to continue doing research there for several years into the future.

And there's lots of questions we have about what we want to study. We want to push back our records to longer time periods. And we also want to develop new methods and test some new methods that others are developing in these regions. And also we are just interested in trying to help the Park understand the potential impacts that they're going to experience from climate change. So kind of some studies of modern, modern climate and climate models working with them. So that's all happening. We're also always trying to fill in other gaps in the paleo climate record. So one of the reasons why we're working in these areas is because there's, they're areas that there's not a lot known and some other regions like the Philippines is another one where there's a need for more records. And so that's one of the places we're gonna hopefully be going to next.

And then also I didn't mention this before, but I have another whole, like, kind of side to a lot of the work that I do. I do a lot of work aimed at increasing diversity in the Geosciences and STEM. And so one of I just had a new project funded by the National Science Foundation. So we got a new grant $7.5 million which I'm very excited about—

JVN // Oh, dang!

KATHLEEN JOHNSON // —Which is focused on training climate scientists, like really traditional kind of hardcore climate scientists, training them in how to translate their science to address issues on the ground that are of interest to communities. So we're training them in, like, community engaged research methods and also in environmental justice, giving them some experience with cross-disciplinary work like in the social sciences, that's going to be taught by my colleagues, not by me. And so that's just launching this year. So we have, like, 17 new fellows, post baccalaureate and phd fellows who are starting in this program that I'm running next month.

JVN // Wow!

KATHLEEN JOHNSON // So it's kind of a different direction than to the paleoclimate, which I'm still, you know, forging ahead with all of that, there's a lot more work to do. But I also like, you know, this impact on students and and on training on people to go and actually work on helping address climate change in a way that is ethical.

JVN // You'd better get ethical and, like, and I think one thing about your research and, and just what you're doing there that I think is so great is that, like, you're bringing your science and your work into so many different areas of life and into your world and into other people's worlds that is just outside of, like, stalagmites, which I think is so great and that you're bringing your passion into more people's lives. Random question for our very end. What is the most surprising fact or thing you've learned about caves and stalagmites in your years? I know it's hard core. But what's the most surprising, or what's the most surprised you've ever been?

KATHLEEN JOHNSON // Oh, my gosh. Scientifically, it's probably something that would not be that interesting to other people. So, I mean, I'm extremely excited about, we just published a new paper using a record from Vietnam, and one of the most surprising things about that, that would only be surprising if you're a person who studies the history of the Asian monsoon and probably speleothems, is that that record is extremely different than lots of other records across the Asian Monsoon region. And that's surprising because there's been a lot of people who've worked in different regions and, and if you look at certain measures, they all look pretty similar. This one was different which caused my student who was working on it, Elizabeth Patterson, it caused her to be slightly concerned, like, "What is up with this story?" But in the end, we came up with a really compelling explanation of it that that location in Vietnam instead of recording, like, the summer monsoon is more sensitive to the autumn monsoon. It has these, like, really kind of shocking shifts between really wet and really dry conditions. And we found out that those are linked to sea level changes because you have this whole, the Gulf of Tonkin and the South China region, the continental shelf along South China during the last ice age, when a lot of water was locked up in glaciers on land, sea level was much lower. And so upstream from our cave site, you had dry land instead of ocean basically. So that led to, like, really dry conditions. And then we have these, like, really abrupt shifts.

So that's like an exciting scientific discovery. But, like, one of, if I can take a minute to tell the story of collecting that sample, and that was probably one of the most, like, actually, like, exciting, like, surprises that happened in the field when I was in a cave. And that was because part of our agreement with this park is that we're only allowed to collect samples that are already broken, you'll just find broken ones in the cave. And that's completely understandable and we're happy to do that. But we started finding pieces of stalagmites on the ground and realized that there were a lot of them scattered around a big area in the cave. So I was with several colleagues and students and we're running around this cave, basically finding more and more pieces and we ended up finding something like almost 30 pieces. And we're, like, "Oh, is this all part of the same stalagmite?" And when they're broken, you can kind of fit them together like a puzzle. And so like, literally like a puzzle. And so we started trying to see how the pieces might fit together. And we're, we have this all on video too. It's kind of amazing. But we got like all of the pieces. We had one gap in the middle and we had one piece left. And so I, like, went over to like put it in and it, like, fit perfectly and like everyone erupted in cheers and it was, like, the most joyful science moment I've had probably!

JVN // Oh my God. What a good way to wrap the podcast. That was such a good

KATHLEEN JOHNSON // It was really, I mean, sometimes honestly, especially, like, during the depths of COVID when I was because this was right before this happened in March 2020 by the way.

JVN // Oh, wow.

KATHLEEN JOHNSON // So, so during COVID, I would go back to that video and just watch it to, like, make myself feel better.

JVN // Oh, honey, what a story. That's incredible. Thank you so much for sharing your work with us. I feel like I learned so many cool things about caves. I'm here for it. I'm, I'm gonna go spelunk right now.

KATHLEEN JOHNSON // Yeah, if you ever want to go spelunk in, you know, Southeast Asia just, just hit me up.

JVN // Ah! Will do, thank you so much, Kathleen! You've been listening to Getting Curious with me, Jonathan Van Ness. You can learn more about this week's guest and their area of expertise in the episode description of whatever you're listening to the show on, honey! You can follow us on Instagram @CuriousWithJVN, yes! Our theme music is "Freak" by Quiñ - thank you so much to her for letting us use it. Our editor is Nathanael McClure. Getting Curious is produced by me, Erica Getto, Chris McClure, and Allison Weiss. With production support from Julie Carrillo, Anne Currie, and Samantha Martinez.