Getting Curious with Jonathan Van Ness & Sebastian Lourido

JVN // We've explored viruses, fungi and bacteria on the show and now we're turning our attention to parasites. Welcome to Getting Curious Sebastian Lourido is an Associate Professor of Biology at the Massachusetts Institute of Technology and a member of the Whitehead Institute for Biomedical Research. He researches deadly parasites and exposes their vulnerabilities. Welcome, Sebastian. How are you?

SEBASTIAN LOURIDO // I'm great. So glad you could have me here.

JVN // So let's start with the basics. What are parasites?

SEBASTIAN LOURIDO // It's a really interesting way to start because I think we have so many different possible answers. I think you've talked about many other infectious diseases and viruses and bacteria and in some kind of general concept, those are parasites because anything that lives on or in us can be defined as a parasite. However, in medical terms, we usually use the concept in a kind of different way and we rule out some of those other groups, we rule out the bacteria, we rule out the viruses, we actually place the fungi kind of on their own category, you treat them with different kind of medicines and then we keep everything that's left. So it's a little bit this catch-all group of organisms that infect us in very different ways. And we can find anything from animals that are parasites that are living inside of us to single-celled organisms that are little protists like the ones that you would see in a little pond of water under the microscope. And all of these are caught in this umbrella term of parasites.

JVN // Is that amoeba that's in lakes that swims up your nose and kills like 99% of the people that get it. Is that a parasite or is that a different thing?

SEBASTIAN LOURIDO // That is a parasite! We would categorize that as Naegleria fowleri.

JVN // That bitch. I read about her once a year and she is out here being deadly. That—you know what, I will not assign Negarius follawager. That is not even a lady.

SEBASTIAN LOURIDO // She is out there, doing her own thing, probably more as asexual than anything else. And it's in the water just doing its own thing. Someone does a cannonball, water rushes up their nose, breaks through the barrier to the brain, and then they just kind of don't know what to do except eat.

JVN // Ew, what's her name again? The fallowery?

SEBASTIAN LOURIDO // Naegleria fowleri.

JVN // Honey, it's giving Nigella Lawson. Okay, I literally just wrote down “Nigella Lawson” instead of writing down what I was supposed to write down. Get out of here. Ok, so how do parasites differ from fungi, viruses and bacteria?

SEBASTIAN LOURIDO // Clinically, just by exclusion. But we're going to be talking about all sorts of different organisms that fall in that category of parasites.

JVN // What's like the biggest parasite and what's like the littlest parasite or we, we're not just a gigantic parasite, right?

SEBASTIAN LOURIDO // Only by the broad definition, not by the clinical one.

JVN // Scary. Ok. So, so what's like the biggest parasite by the clinical definition?

SEBASTIAN LOURIDO // Probably some of the parasites that live in our intestines, which can be a meter long.

JVN // [GASPS] Like a tapeworm?

SEBASTIAN LOURIDO // Like when we think about some of the tape worms. Yeah. Exactly.

JVN // Oh, fuck. Ok. And then like the tiniest one is just like those little tiny, like single cell ones in like the water.

SEBASTIAN LOURIDO // Exactly. Or the ones that would cause malaria, which are really, really tiny single celled organisms that live inside the red blood cells. The ones I study—toxoplasma, which we'll get to later. Those are maybe 1/100 of the width of a human hair.

JVN // Wow. 1/100 of the width of a human hair. Yeah, that's so little. How do they reproduce? Like two parasites? Get it on? It's, it's New Year's Eve and they have a few glasses of champagne and then they fuck in your intestines. No. What happens?

SEBASTIAN LOURIDO // Sometimes there are, like, these incredible love stories, right? Of, of these parasites that have just, like, navigated open bodies of water to enter the skin of some host and then just made a voyage across the blue blood stream all the way into the intestines and then gotten out and, and actually found their beloved and then they mate for life. Right? And so this would be kind of the stories of schistosomes, and then they just produce lots and lots of babies that make us sick.

JVN // And then, you know how, like yeast, like, spuds, like, or just, or not, it doesn't, but it just like, splits in half. Like those one things that just split in half do any parasites just, like, reproduce by splitting in half and they don't even have to or—asexually!

SEBASTIAN LOURIDO // Yeah, exactly. Lots of them do. And so Naegleria, which we were talking about—

JVN // Fowleri?

SEBASTIAN LOURIDO // Yeah!

JVN // Not Nigella! Nigella is out here just splitting in half?

SEBASTIAN LOURIGO // Just splitting in half, making more. And so you really, in some of those cases, you need one and then it can make a whole bunch of them. And that's also the case with some of these single celled ones that I was telling you about that are so small, they'll like enter our bodies and just start making more and more and more.

JVN // What about? Okay, Jonathan, focus. My ADHD is really intense today. Um… okay. So I'll write that down for later. I'm just writing down everyone. If you're curious, "STI parasites," we'll circle back to that later. Okay, so some do asexuals, some do sexual. Is there any other types of reproduction besides asexuals and sexual?

SEBASTIAN LOURIGO // I think one of the really interesting historical elements of, of parasites is that in some cases they transform so much, they look so different, they change in size, they have tails in one stage and then lose them in another one. And so originally, sort of before we had ways of, of really identifying that the genetic material was the same across all of those different forms. It was actually really hard to put the whole picture together, right? Because you had these things that you were seeing in free water and looked one way and then you found them inside a person and they look a completely different way. And so in, in some ways, even though broadly, we can talk about sexual replication and asexuals replication, they also go through all of these incredible

transformations where their entire body plan changes, what they can do, what they resist. In some cases, they resist going through our intestines. In other cases, they will be killed by those acid pH. And so we can imagine them as these kind of incredible shape shifters that can specialize their body plan to a very particular place within the environment or within ourselves as hosts.

JVN // So, like, not only is there asexuals and sexual reproduction, but there's also like it's giving like butterfly metamorphosis or something like there's like just total. Ok. That's really interesting. What's the one that like has to be inside a host or it can't live very long?

SEBASTIAN LOURIGO // So we would call those obligate parasites, right? They can't do anything else. And many of the parasites that we've been talking about are obligate parasites, they'll only replicate inside of their host. Others like our friend Naegleria will be able to just replicate in the environment, do its thing and then opportunistically it'll find itself inside of us and find kind of a rich source of nutrients, right? The other kind of like big topic in parasitology is this notion that, that we are these ecosystems in ourselves. Like we have all of this concentrated energy and metabolites and, and glucose and, and it's sort of much richer within us than it is out there in the environment, which is why any organism that figures out how to, like, tap into that is gonna have a huge advantage in terms of growing and replicating and, and making more of itself. And so we are these sort of, like, bountiful banks of metabolites and these organisms have figured out time and time and time again, how to tap into that.

JVN // Are you scared of, like, a Last Of Us parasite event?

SEBASTIAN LOURIDO // I actually think about it as much more of, like, a self-regulated system, right? That when there are these events where we get a new infectious disease and it can be sort of like COVID kind of spread like wildfire and it can be pretty bad, but there's a way in which things self regulate and then persistent hosts start emerging. And all of a sudden you have what's her name, the main character? Making more babies and like the population takes over and so it equilibrates.

JVN // Okay, okay, okay. Because you think it's, like, so maybe it's, like, maybe it's okay?

SEBASTIAN LOURIDO // I think.

JVN // Okay, great. Okay, cool. That makes me feel better.

SEBASTIAN LOURIDO // Also, like, as a species we've seen a lot. Right. We've been around all of these organisms and we've been exposed to many things and so just like they have tricks up their sleeves. So do we.

JVN // Yeah. But then the dinosaurs, but then that was a fucking meteor, not a parasite. So as long as we don't get a meteor, like, we're probably going to be cool, we'll probably be OK. Oh my God, I'm obsessed with this. This is the most fun I've ever had. Like, we've been so much on this podcast. I can't stand it. Ok. So—

SEBASTIAN LOURIDO // I will say maybe just listen and aside that when a species is very successful, figuring out how to crack that vault, it has a big payoff for pathogens, right? And so you can imagine the human race and like all of these people, if you figure out how to reproduce in a person, you can make a lot, a lot of, of these pathogens and they can spread quickly.

JVN // So, like, some just exist and they're just chilling in the water or wherever, like, in the soil and the water, wherever. And they only become, like, a parasite, like, once they enter

somebody, other parasites, do they die if—like, how do they jump between hosts? Like how do they live between being in a host?

SEBASTIAN LOURIDO // Yeah. So we can think about a bunch of different routes of transmission and one very common one will be for parasites that live in our intestines. What comes out of our intestines and contaminates water, contaminates soil. That's a good place for someone else to walk over, drink a glass of water and, and get that same parasite in them again. Right? And so this is what we would call a fecal-oral transmission cycle. And we can think about many different parasites that get transmitted this way. Of course, you need poor sanitation for that to be the case. But of course, that's been the case for a lot of human history and it's still the case in many parts of the world, unfortunately.

JVN // I hate shitty beverages.

SEBASTIAN LOURIDO // Exactly.

JVN // As someone who studies parasites, like, because it's probably hard to talk about because it's, like, they all have their own thing because it's, like, a catch-all for all these different things. So, and you were saying that you study which one again?

SEBASTIAN LOURIDO // Toxoplasma gondii.

JVN // Is that toxic blood, something—like, toxic plasma?

SEBASTIAN LOURIDO // No!

JVN // What is it?

SEBASTIAN LOURIDO // Toxoplasma, the name originates from “bow shaped,” which is “toxo.” And plasma is shape.

JVN // Oh, so not blood at all!

SEBASTIAN LOURIDO // It's bow shaped.

JVN // Ok. Fierce. Ok. So that's like one kind of like, can you just give us like a couple of categories of like a parasite? And then like—

SEBASTIAN LOURIDO // Yeah, sure. Another one that I would like to mention when, under the transmission cycles, because I think it's really important to consider is that sometimes they are vectored by blood-sucking insects. Right. There's all of these different insects that—

JVN // Vectors! Yeah!

SEBASTIAN LOURIDO // And so that's a really, really important way for these parasites to be transmitted. And then the other way is through carnivorism. And so if you eat the flesh of an infected host, that parasite now finds itself inside of you. And so we can also think about that as another route of transmission.

JVN // Okay, the way that you just said “carnivorologist.” just makes you feel like you're a vegetarian.

SEBASTIAN LOURIDO // No, I dabble. I'm a pretty big Omnivore. I would say.

JVN // Omnivore. So. Ok. OK. So like, so we just really need to cook our shit real good. Just like cook that shit real good. Are you not out here eating oysters and stuff? Like, do you not

eat raw shit or what? Like, as someone who studies parasites, what do we need to avoid to not get a goddamn parasite? Like what do you *not* do?

SEBASTIAN LOURIDO // I mean, I think you are right, but I like a little bit of risk in my life.

JVN // Oooh! Oh! Oh fuck!

SEBASTIAN LOURIDO // I don't mind a parasite. And so every once in a while I'll, I'll dabble in some undercooked meat. Oh, but you know, if you want to be super safe, which has its costs as well, you definitely have to cook that stuff. Maybe minimize the number of filter feeders you're eating. And so that, that raw oyster. Yeah. That's really fresh…

JVN // Shit! I fucking love oysters!

SEBASTIAN LOURIDO // I know. And actually this is one way in which there's this dichotomy between farming practices. And so some of the more sustainable small agriculture farming practices also carry with them the fact that they are going to carry more parasites and there's going to be more crossover between different environmental factors and the food that's being produced compared to this large scale agriculture where you might be able to keep higher levels of sanitation overall. So that's sort of one thing to consider as tradeoffs.

JVN // But then you were saying, like, if you get *too* safe girl, then like you're your shit's not gonna know what hit it when you actually do like get exposed to something. So you gotta be a little risky sometimes.

SEBASTIAN LOURIDO // I think so. Also because we're here for a short period of time and we have to enjoy life!

JVN // Do stuff. Yeah, you're so right!

SEBASTIAN LOURIDO // You're just ruling things out left and right because of risk, then I think you kind of end up living in a bubble. Damn, you're hitting us with the truth bombs when we were learning about parasites, honey! I am feeling it, Sebastian.

JVN // Ok. So, ok. And then vectors just in case you were wondering, vectors are, like, the things that carry something, right? Like what's, like, the definition of a vector?

SEBASTIAN LOURIDO // Yeah, there would be some sort of thing that would carry a pathogen from one host to another. In parasitology, we typically think about vectors as these kind of blood-sucking insects—like, ticks or fleas or mosquitoes, right? Which are constantly going from one individual to another, taking body fluids like blood.

JVN // But we can be a vector too. Like humans can be vectors of disease too, right?

SEBASTIAN LOURIDO // Sure. Particularly children. No, I'm just kidding!

JVN // But it's true! But, like, so, so—like a vector of like in a parasite or like a virus or like whatever, it's just like something that, like, carries something around.

SEBASTIAN LOURIDO // Yeah. And it can be a pretty broad definition depending on how specific we are and, and what the functional role of that definition is.

JVN // And then remember how you said, like, "obligate parasite"?

SEBASTIAN LOURIDO // Yeah.

JVN // What's, like, another parasite that's not an obligate parasite.

SEBASTIAN LOURIDO // There are a bunch of these amoebas related to our friend, some which are found in the intestine, some which are found in your eye sometimes and they'll be

kind of coming again from the environment and coming back in. There are a bunch of the obligate parasites that are still found in the environment, but they're kind of dormant in that stage. And so they will form some sort of, like, an egg-like thing. We typically call them oocytes or cysts and then those will survive just long enough to then be consumed back again into, into a host.

JVN // Oh! OK. Can you give us an example? Just because I'm still trying to wrap my brain around it because I'm obsessed. Can you give us an example of like an obligate parasite and then like a not obligate parasite?

SEBASTIAN LOURIDO // Yeah. So an obligate parasite would be something like malaria. It only reproduces inside of its hosts. It happens to have two different hosts, right? It happens to have something like a vertebrate like us and it happens to have an insect host, but you'll never find it out in the water or in the soil replicating away. It just never makes it out there. It would die if it found itself out there. And non-obligate parasite would be something like these amoebas which are eating bacteria out in the water. They are doing their own thing. They're eating enough to replicate, they're making more of themselves and every once in a while because of the cannonball and like rushing up our, our brains, then they find themselves inside of us and then they start replicating.

JVN // Oh my God, I understand! Oh my God. I'm so excited. That was really good Sebastian! Oh my God. Oh Yeah. OK. So what makes a parasite harmful to some species and not others?

SEBASTIAN LOURIDO // Yeah. That's a really fascinating question. And I think that there are, there are many different aspects to it because when we think about host parasite interactions, there are so many different interfaces, there's metabolites and what are they taking away from us? There is the immune system that is suppressing their replication and then they are fighting against that immune system and kind of overcoming those restrictions. And so when we think about all of those interactions, they can kind of break down either to completely control the parasite or for the parasite to kind of overcome the restrictions and then replicate in an uncontrolled manner and cause disease. And so we can really imagine that going multiple ways. And so let me tell you a story about one of these animal parasites. And we have talked about tapeworms earlier, right?

The life cycle of the pig, tapeworm—Taenia solium—occurs between pigs where it finds itself all over the muscle of the pigs and different tissues. And then when we consume that tissue because we didn't cook the pork properly, then it'll develop into a tapeworm in our intestine. Those tape worms are fascinating. Actually, they're sort of like colonies of individual organisms. They are hermaphroditic and they make in the different sections of the tapeworm, they're gonna make eggs and then those pieces are going to be shed out and then to complete the life cycle, a pig's gonna run around and eat that and now it'll develop into this entire thing.

JVN // The pigs eat shit?

SEBASTIAN LOURIDO // Pigs do eat shit.

JVN // Fuck!

SEBASTIAN LOURIDO // I know. So when we kind of like, think about that scenario that I just painted a little gross, but actually it's in harmony and in those different species in the pigs, it's not causing that much disease in us. In the intestine, we can have those tape worms for years, maybe decades.

JVN // Do we have one now, maybe?

SEBASTIAN LOURIDO // I doubt it. Not, not in Boston, not in LA!

JVN // Because it'd be giving, like, Ozempic, like, I'd be so thin or no?

SEBASTIAN LOURIDO // Not necessarily. It kind of depends. That seems to be a myth. I think so. I mean, I think in high parasite burdens then you'd be, like, anemic and, like, all sorts of other stuff would be going bad. I don't think that there's like a one stop solution of getting a tapeworm and then being thin!

JVN // Fucking, do we need to change the title of our podcast to Mythbusters? Because we just, like, Sebastian, like, get out of here, that's amazing! Ok. So basically, it's just like some parasites need, like, certain temperatures or certain, like, acidities or certain, like, alkalinity or whatever. And like, so that's why they're a host for some and not others.

SEBASTIAN LOURIDO // Exactly. And where you can have these very different forms, right? In the pigs, they're in these tissues and these cyst-like things and then in us they make a whole tapeworm and start reproducing and maybe making eggs and, and I was painting this picture because in that scenario, there's harmony. But if we have, like, fecal oral transmission and we get the eggs in us, then the parasites kind of don't know what's going on, they will start developing and going out of the intestine into tissues and then you find them in the brain, in the eyes and in all sorts of different tissues and they start causing disease. And so this is where we would actually then start thinking about it as an infection that can cause a disease called cysticercosis.

JVN // What's that?

SEBASTIAN LOURIDO // It's the name of that disease caused by the pig tapeworm.

JVN // But what does it cause? What does it cause!

SEBASTIAN LOURIDO // You have all of these compromised tissues and in bad cases, you can have neurological symptoms because of the inflammation associated with having these parasites in the brain.

JVN // So, in a pig, it infects their tissue but they just get cysts and it doesn't really hurt them. But in us, like if you get the eggs in you, which would happen from you literally eating pig shit, which would be, like, if you were on a farm or something and maybe you just didn't wash your hands and it was some microscopic little egg or something. Ooooh, and then it crawls out into your shit. And what are those worms that people would shine lights on their butt holes and the worms would come out in the middle of the night? Were those parasites?

SEBASTIAN LOURIDO // Yes. I think that those would be the soil transmitted helminths, things like pin worms and the like. I didn't know about the light!

JVN // Yeah, they got, like, a light where, like, they would, like, on your butt hole and, like, the worms would come out. Is that a lie? Is that another Mythbuster?

SEBASTIAN LOURIDO // I don't know enough about these.

JVN // Erica, Google! Erica, Google! Someone Google the worms that come out of people's buttholes in the 60s! Okay, so we'll find that out later. So, ok. So I think I understand why, like, they're harmful to some and not others. Did you finish that thought? Because, like, I'm so obsessed with your scientist's brain right now. I can't even stand it.

SEBASTIAN LOURIDO // The, the thought is really one about adaptation, right? And about these organisms really being dialed in to, like, a very specific place and a very specific set of conditions. And in, in those scenarios, when they've adapted perfectly to a host, it is

possible that if they don't need to make that host sick to be transmitted, then they will actually be better off by not making the host sick and sort of continuing to live in harmony. And so you can have these instances where parasites are exquisitely adapted to a host so much so that you might not even know that they're there.

JVN // Ok. That's cool. Is that like the bugs that eat, like, our eye crusties, like, the microscopic little things that live on our skin that gross me out when I learned about that in eighth grade and I couldn't stop thinking about how disgusting our skin looks under a microscope?

SEBASTIAN LOURIDO // Little mites. We also have bacteria, right, that live in harmony in our intestines and on our skin.

JVN // But what about the mites? Are those parasites like the little skin mites? Would that be a parasite or are they like bugs?

SEBASTIAN LOURIDO // They are ectoparasites.

JVN // Ecto—does that mean outside of you parasites?

SEBASTIAN LOURIDO // Yeah!

JVN // What about bedbugs? No, that's a bug. That's an animal. That's not a parasite, like, bedbugs—because they don't live inside something.

SEBASTIAN LOURIDO // Well, there's a little bit of a continuum there, right, where some are living off of our blood. And so you can consider them parasites very much so. You can have mosquitoes and some of these other blood-sucking insects which are parasites of, of us and sometimes parasites of other animals. But there's a continuum in where, where they might have some free living stages and they might certainly go out there and do other stuff. Right. In the case of mosquitoes, it's only the females that are eating blood and the males are out there eating nectar and like little sap and stuff.

JVN // Oh, I didn't know that it was only girls that eat our blood.

SEBASTIAN LOURIDO // They need it to make eggs! Ok. So, but you study parasites that are harmful to humans. Interest. Do I even want to know how many parasites fall into this category? Like, no, probably. Right. Like, just, like, millions?

SEBASTIAN LOURIDO // Probably hundreds.

JVN // Oh, good, good, good, good.

SEBASTIAN LOURIDO // I think if we were to kind of consider all of the species that have been at one point or another found in people.

JVN // Oh, that makes me feel better. Like, yay, that it's only hundreds! Ok. Cool. What are like the top three, most common parasites that affect humans?

SEBASTIAN LOURIDO // Oh, gosh!

JVN // I love a top three.

SEBASTIAN LOURIDO // A top three. Ok. I think we would have to probably start with malaria in terms of its global distribution.

JVN // Oh, yeah, that’s really good.

SEBASTIAN LOURIDO // There are a few different species that are very common in humans. So there's plasmodium falciparum, which is very deadly and primarily is found in Africa. That causes malaria. That's the species name of the parasite that causes malaria.

JVN // Oh, it's just, ok. So that's the bronze metal. Malaria gets the Bronze. Who gets the silver?

SEBASTIAN LOURIDO // Malaria gets the gold? I'm sorry that I started in the wrong order.

JVN // Oh, no, that's ok. Sebastian, you never apologize to this podcast! Never. We are not. You're brilliant. Ok. So gold medal: malaria! Who gets the silver?

SEBASTIAN LOURIDO // We're gonna give it to a group called trypanosomes.

JVN // What do they do?

SEBASTIAN LOURIDO // Trypanosomes comes from the Latin of "whip" because they're whip-shaped and those are going to be found as African trypanosomes. They are, like, in the blood, they're transmitted by these blood sucking flies called tsetse flies, and they cause a disease called sleeping sickness.

JVN // [GASP] I've heard of this. Now, why do those flies live in North America!

SEBASTIAN LOURIDO // They had a hard time getting visas! No, I'm kidding.

JVN // But they just don't like the temperature or something? Like I, I, I'm just asking because I'm scared!

SEBASTIAN LOURIDO // The environment's not right. And so they're really restricted to a particular environment. Yeah.

JVN // Ohmigod, I hope they don't adapt to North America and, like, catch you right on a plane or something.

SEBASTIAN LOURIDO // But, well, this is a consideration, right? With global warming as climate changes and you have these organisms—

JVN // Oh, oh god, you guys! I knew it! Ok. So what does sleeping sickness do? It just makes you not able to sleep or you can't wake up.

SEBASTIAN LOURIDO // It disrupts your circadian clock—

JVN // Ohmigod.

SEBASTIAN LOURIDO // Because these parasites will start replicating in the bloodstream and they'll make it into the brain and into the fat tissue. And they actually end up really changing the metabolic composition of those tissues in such a way that it kind of deregulates the circadian clock. It also makes you very sick, very—

JVN // Do you die?

SEBASTIAN LOURIDO // If untreated, those cases of sleeping sickness are lethal.

JVN // How do they treat it?

SEBASTIAN LOURIDO // You know, this is another concept where we have some compounds against all of these parasites as we get to pathogens that are closer and closer to us. Evolutionarily, they look more like us, they actually become harder to treat, right? Because you have to develop treatments that kill them but don't kill us.

JVN // So, trapozomes look more like us.

SEBASTIAN LOURIDO // Trypanosomes, compared to bacteria or viruses, they definitely look more like us. They have their genetic material in a nucleus. So they belong to this big group of living things called eukaryotes. And they are going to have a lot of cellular machinery that looks much more like ours than for instance, a bacterial, cellular machinery would or even a viral machinery, which of course they take advantage of our own cellular machinery, but they have things that are very specific.

JVN // OK. That's so fucking cool. OK. So then who, who gets the bronze after sleeping sickness? And the trypanosomes.

SEBASTIAN LOURIDO // Let me mention another tropazone because that silver medal is shared.

JVN // I love a tie!

SEBASTIAN LOURIDO // This one's really interesting. The trypanosomes kind of split out into these two different groups. When the Americas in Africa split up and in America we have the American trypanosomes—

JVN // Ohmigod—

SEBASTIAN LOURIDO // They go through, like, South America all the way into the Southern Us. And those are transmitted by these really weird blood sucking beetle-like things called reduviid bugs. Sometimes they're called kissing bugs and those kissing bugs and they're big and they fall on you and they'll suck some blood often from, like, tender tissue, like around the eye. And then you'll have those American trypanosomes—Trypanosoma cruzi—replicating right there causing kind of like inflammation. But then they kind of go all over and, and those have the ability to actually replicate inside of, of cells and, and in that state, they're actually able to evade the immune system and persist for really, really long periods of time. And so then years later, after having contracted this from the bite of a kissing bug, you have these people who come into the clinic with enlarged hearts, enlarged colons and esophagus. And that's because over time, that kind of, like, replication and control and that stalemate between our immune system, the tissues, it starts degrading the tissues and creating, like, less stability for some of those vital tissues like the heart. And then these big hearts can't pump well enough. And that's called Chagas disease.

JVN // I've heard of that too!

SEBASTIAN LOURIDO // Hopefully not in any friends and family.

JVN // No!

SEBASTIAN LOURIDO // It’s a very bad condition.

JVN // Is that better if you catch it early or something? Like if they catch it, like when you get the initial bite, can they give you some shit if they're like, “That's a kissing bug bite.”

SEBASTIAN LOURIDO // Definitely. But again, in some cases, because there's not enough research into these organisms that the tools that we have to fight them are really bad and in some cases really toxic to, to people. And so you're kind of stuck in between, like, “Well, we have to give you this because that's the only way we have to kill these things. And it's also making you really sick. And I'm sorry.” And really with more research could definitely devise compounds that are better able to discern between the pathogen and the host. And so would be better therapeutic compounds. And there are certainly many labs around the world, particularly in academia, but sometimes with partnerships with industry that are trying to develop those kind of next generation of antiparasitic compounds.

JVN // Okay, that's fucking cool, too. OK. Who gets the bronze?

SEBASTIAN LOURIDO // I'm so interested in so many of these that it's, like, really hard for you to make me pick. And so I'm cheating a little bit and I'm giving you broad categories that I can then delve into. So the bronze is gonna go to, to helminths, which is what we call the different kinds of, of worms that infect us.

JVN // Butt worms!

SEBASTIAN LOURIDO // The butt worms. Things like hookworm. We would have things in there like mosquito-transmitted worms. These are called Filaria and we would have in there some of the round worms that are the soil-transmitted helminths.

JVN // That's the one that Carter eradicated, right? Like, those guinea worms or something that, like—

SEBASTIAN LOURIDO // Those are guinea worms, yes!

JVN // And doesn't it, like, crawl out your feet or something?

SEBASTIAN LOURIDO // Oh, those are so interesting. Also, they haven't been completely eradicated, but boy has that eradication campaign gone. Well, they might be the second human pathogen to ever be eradicated after causing so much morbidity. Right. I think another concept here is that we get really interested when these pathogens are killing people, actually making people sick, unable to go to school, unable to work, particularly in developing countries. That can be a huge burden on those populations. And so we also need to be thinking about how sick are these people getting from these diseases when considering what sort of public health interventions we go and, and place. And, and that was one of those where that is transmitted from those worms finding themselves in these copepods, which are basically micro crustaceans, very, very tiny shrimp-like things that are in water. And then people will drink that water and then they'll find their way into, into the host, into people.

And then from there will migrate over to the lymphatics where they'll become these long worms that in order to reproduce will sort of burst out of these very painful lesions usually at the base of the leg and deposit their eggs into water where they can continue to develop and find new copapods to complete the life cycle. Right? And so in, in that instance, you then have this worm that's kind of, like, hanging out. But it's this very, very thin thing that is woven into your lymphatics and is very difficult to pull out because it's very soft and tender. And so the solution is basically to get a little stick and wrap it around and then just turn that stick a couple of turns each day to slowly pull that worm out of the lymphatics. That's sort of the solution to having an adult guinea worm living inside of you. It's actually thought that that kind of concept that wrapping of the guinea worm around the stick was the basis for the, the medical symbol—the caduceus—where it's actually like a snake wrapped around the stick. But that it's this very kind of ancient concept of how you would treat these particular types of lesions.

JVN // Wow. So is, now do we have an oral for that too? And the stick? So that it can at least like kill the fucking thing in you while you like twist it up out of your lymphatic system?

SEBASTIAN LOURIDO // That's what's so beautiful about the eradication campaign. That what it's taken is essentially controlling some of the people who are infected so that they don't go into the water and spread more eggs. And giving people little filters. And so they go into villages where these infections are endemic and they'll say, "Ok, instead of just drinking water, just drink it through this little straw that has a filter on the end that captures those micro crustaceans." And through those kinds of interventions and, and education to

basically break the transmission cycle, you've managed this really unbelievable control of, of the infection. Since in this instance, we are pretty much the only host around. And so if you control it in people, you control it everywhere and you're able to eradicate this terrible infection.

JVN // But we could find it in, like, zebras one day.

SEBASTIAN LOURIDO // Yeah. And actually they're finding some small reservoirs but it's still controlled enough that, that we think that it can still be eradicated.

JVN // But you are obsessed with toxoplasma gondii, honey. So what's the deal with that parasite? How does it work? What's the tea, what's going on?

SEBASTIAN LOURIDO // So that one also has an interesting life cycle. We can think of that life cycle as being split between where the parasite has sex and where it is asexual and just making more of itself. And so we would call the asexual cycle, that would be the intermediate host. And that includes humans. It also includes mice and birds and pretty much any warm-blooded species. So, whereas we've talked about some of these as being very specific, toxoplasma is a generalist and can find itself in any species that has the right temperature for it to grow. But then the definitive hosts are special. It'll only undergo its sexual cycle inside cats.

JVN // Oh man. Okay!

SEBASTIAN LOURIDO // And there, once it undergoes all of its sexual cycle, basically, the the asexuals will infect the intestines of the cat. They'll start replicating and then they will make micro- and macrogametocytes, which we typically think of as male and female gametocytes. But that's just kind of a technical definition for the big cell. And then those will come together and then the product of that will be this oocyst, which is this very environmentally resistant, like, shell-like thing where the parasites can just survive out in the cat feces and in the environment until they are accidentally consumed by one of those intermediate hosts. And that kind of completes the cycle.

JVN // And an intermediate host can be a…

SEBASTIAN LOURIDO // Any warm blooded animal.

JVN // So if my dogs eat cat shit, they could get it.

SEBASTIAN LOURIDO // Absolutely.

JVN // So Elton definitely has toxoplasma gondii.

SEBASTIAN LOURIDO // Well, it depends how it might have entered your home, right? Because I think you also need the cats to have contracted it somewhere and they would contract it by eating some of those intermediate hosts like mice or birds.

JVN // Ok. Well, I've only had one of my cats capture one bird once.

SEBASTIAN LOURIDO // Okay, that’s good.

JVN // And they, and they didn't eat it but did draw some blood, but like it, it flew into our sun room. I don't know how Baggy did it. Mark caught it. The bird lived. But, so do you think that, do, do all my cats have toxo—but they’re all indoor.

SEBASTIAN LOURIDO // They’re all indoor. Cats can be sneaky, though. But, but you probably don't have any mice. So I'm gonna say the chances are very low.

JVN // Should I treat them all, for it?

SEBASTIAN LOURIDO // No.

JVN // How do they? Oh, God, do we have? Is that, but that's why pregnant women can't handle cat shit, because of toxoplasma gondii.

SEBASTIAN LOURIDO // Yeah! And actually this is sort of like an interesting concept. So how bad is toxoplasma? We actually can tell because people have antibodies against toxoplasma who was exposed and who wasn't. And then we believe that the people who are exposed probably carry it with them for life. And we can kind of, like, talk about what that looks like. Depending on where you sample, in the US, maybe 10%, so like one in 10 people have antibodies against toxoplasma. In some parts of Europe, it can be 50 60%. And a lot of this probably varies with sources of water and sources of, of their own diet. And sort of, like, what the gastronomic predilections of the place are where I grew up in, in Cali, Colombia, the incidence rates like 64%. And in fact, I'm a statistic in that sense and, and so I contracted it when I was probably 17 and I developed, like, swollen lymph nodes. What is this? They couldn't kind of figure out what it was. And then they tested my blood for antibodies against toxoplasma. And boom, lo and behold, I got toxoplasma. As long as I am healthy and I have a healthy immune system, it seems to be no problem.

In some people, it can replicate for a little bit in the eye and that can be a problem in terms of losing part of the retina and creating some, some eye loss. But it seems to be a very small fraction of the overall infected individuals who develop those. And then when it can get really serious is in those two cases, one of which you mentioned. The first one is if a woman is pregnant because these parasites are replicating and going kind of all throughout the body, if they find themselves in what we call these immune privileged sites, where your immunity kind of just doesn't reach as deeply or in the same ways that can be the developing fetus. If it finds itself there, it'll replicate like wildfire and, and cause a lot of damage to tissues. In some cases, those babies can be either aborted spontaneously or develop complications from the replication of the parasites in their brain, in their eyes. And so there, it can be really bad. And the other case where it can be really bad was in immunocompromised individuals. And so this was one of those infections that would flare up in patients with AIDS, right? Where their CD4 T cells would drop and their entire kind of immunity would wane there. The parasites would reactivate from whatever reservoirs were found throughout the body and they would start proliferating and cause a lot of harm and particularly cause a lot of harm in the brain. So you'd have cerebral toxoplasmosis.

JVN // Uh! But as long as you're undetectable and your CD4 count’s real good, like, you're gonna be fine, even though you have 17,000 cats.

SEBASTIAN LOURIDO // Yes! No, absolutely. And in fact, like, clinically we see that people who are treated with antiretrovirals who stay healthy, they don't have these infections anymore. So it's really a kind of transformation of what it means to be HIV positive.

JVN // So when you're handling cat shit, we have our Litter Robots which are great. Like, so it's just like, but, like, how can we—if you have cats, like, what do you do? Just like, make sure you're like, really like putting on gloves or something and wash your hands really good. Don't pick up cat shit with your bare hands, definitely don't eat it. But if your dog's licking you and your dog eats cat shit…

SEBASTIAN LOURIDO // Then maybe keep the robot in another room?

JVN // You're so right. I have to be like a cat door for the litter robot. So that only the cats can go in there. You're so right. We have to cut Elton off from the cat shit.

SEBASTIAN LOURIDO // I think so! Cold turkey. You can also change the kitty litter daily. It actually takes like 24 hours for the cysts in the cat feces to actually become infectious.

There's some other transformations that have to happen in there. And so that's kind of another global recommendation for people to mitigate the risk of infection.

JVN // Can we get our cats tested for it to see if they've had it? Can you test cats for the antibodies?

SEBASTIAN LOURIDO // The tests we have are kind of that way for the antibodies. In reality, when a cat gets infected, cats will also mount immunity. And so the period during which they'll actually shed these products of infection are brief and, and compressed. We don't totally understand exactly how it goes. But, but it's certainly the case that a cat that is positive, like, if you, if you test your cats and they're positive, it doesn't mean that they're infectious or, or shedding oocysts. Should

JVN // Should I get an antibody test? I want to know if I have it!

SEBASTIAN LOURIDO // You could, but there's no real risk to you. And so if you don't have symptoms, it's just one of these things.

JVN // I need to know if my cats have toxagondi!

SEBASTIAN LOURIDO // It's better not to know.

JVN // No, I wanna know! So when did scientists first learn about this toxin plasma Gandhi?

SEBASTIAN LOURIDO // It was actually almost a simultaneous discovery between two different places. There were some researchers working. One of them was Alfonso Splendore. And this was a time where people just had gotten kind of good microscopes and any time that anyone was sick, they were throwing stuff under the microscope and seeing whether there was any anomaly there. And so they were finding left and right, all of these different organisms that were associated with, with, with these diseases that we had known about for a long time. So there was, like, malaria and, and the trypanosomes had been discovered and different types of associated trypanosomes had been discovered so very fertile time for, for science. And these researchers were working with different animals that got infected and they were kind of trying to bring these infections in, into the laboratory settings. And so one of them found it in rabbits in Brazil.

Another one, Nicolé was working in Tunisia and the Pasteur Institute there and founded in these African rodents called gundi. And so eventually the species got the name of the organism that they had found it in, toxoplasma gondii for gundi, right, because that was sort of the first paper that was published, this was, like, 1907 or 1908. And then they started finding, "Oh toxoplasma over here and over there and in this organism in this other organism." And then around the forties and fifties when better techniques were being developed. They started bringing all of these together. Actually, they're not different species and different hosts. They're actually the same species that's going throughout all of these hosts. And so they were all gathered together under this single species named toxoplasma gondii. And even though there are differences, just like we would find for the COVID-19 virus throughout the world, very different ways in which isolates differ. They are all the same species and they seem to retain the capacity to recombine with one another.

SEBASTIAN LOURIDO // Wow. Ok. Oh, also you guys, worms that come out of your butt with a flashlight. I have confirmation. You guys, I was, it's, they're pinworms. The best way to determine if you have pinworms is to shine a flashlight on the anal area or the tape test you guys and it does happen like, yeah. So thank God, that's true. I was the way you reacted. I was, like, "Oh my God, like…"

SEBASTIAN LOURIDO // No, I'm glad that I wasn't like, "Nah!"

JVN // It was really my auntie, when she was little. But then when you, I was, like, “Oh my God, was my grandma just, like, looking at her butt hole with a flashlight because she was like, crazy? Like, I hope she wasn't, like, being untoward!”

SEBASTIAN LOURIDO // No, no!

JVN // No, but no, it was, it really was butt worms.

SEBASTIAN LOURIDO // Well, I've learned something, too.

JVN // Yeah, pin worms, honey. Who knew!

SEBASTIAN LOURIDO // This is where my specialty really is in much more the molecular and cellular aspects of these parasites. And I've spent most of my career studying toxoplasma. And even though I'm fascinated by some of these other parasites, there's still a lot that I have to learn.

JVN // There's literally 100s, Sebastian for fuck's sake. Like, you're literally, like, so amazing we can't stand it. So I am freaking out about this toxoplasma! I'm not gonna lie. I'm, like, a little scare scare. So if, if, but it's fine. So, but your lab is working to keep us safe. Right? Right?! Like—

SEBASTIAN LOURIDO // Absolutely!

JVN // It’s fine. We're gonna get rid of and catch it.

SEBASTIAN LOURIDO // Well, actually, one thing that we haven't discussed is sort of, like, what happens in a healthy individual, like, where does the parasite go? What does it do? And really we can think about what happens in us in these two phases. In one, the parasites are replicating like wildfire. They're growing very fast. By the way, toxoplasma can only replicate once it enters a host cell. And so if we think about our cells and different tissues, it'll go inside sort of push its way in, create a little compartment where it can gather nutrients from that cell, but it's sort of isolated from the rest, it is isolated from the immune system and there it starts making more and more of the cells and it grows like crazy. And then eventually they'll kind of burst out, find new cells and keep replicating.

You can imagine that that process, which is happening every, like, 40 to 48 hours is bursting out. Infecting new cells is going to eventually cause tissue damage and inflammation and elicit the immune response. And so immune cells of different types will come in, will control the infection, will start killing the parasites, will start gobbling them up and the parasites seem to actually have an ability there. And we don't quite understand what the signals are, but they'll transform into these ones that are just growing more slowly and they are no longer lying out of the cells in that form. They can then persist for a really long period of time. And so we think of that as the chronic phase of infection. So the inflammation starts kind of going away, there's an equilibrium that's reached between the immune response and the parasites. And then in that phase, they can actually stick around for the life of the host. Right? And in, in lab experiments, with lab animals, we can see these organisms just persisting there for a really, really long time.

JVN // Is that specific on the parasites that they burst out of cells? Because, like, do viruses do that or do they not burst out of cells?

SEBASTIAN LOURIDO // Some viruses do, right. They'll replicate a ton, a ton, a ton and then they'll burst the cell open other viruses bud, right? And viruses are different in that they’re sort of using our machinery and in particular, the machinery that we use to make proteins, which would be in the case of a viral infection, the viral proteins. And then those get packaged in different ways. They either make little particles that are just self contained

and just protein and then the genome of the virus. Or in other cases, they might take part of the membrane of our cells and sort of arrange it—like HIV—together with some viral proteins that are studying that membrane and make a little encased particle. And so those can sometimes emerge from cells without killing the cell.

JVN // Interesting. OK. But do all parasites do the bursting thing?

SEBASTIAN LOURIDO // All of the intracellular parasites have to burst out in order to find new host cells to, to infect and that's what's happening in malaria, right? They'll enter a red blood cell and then they'll replicate inside of that red blood cell and then burst out and find new red blood cells. And so you get these waves of parasites bursting out and your red blood cells exploding.

JVN // Has anyone ever, like, cured themselves of toxoplasma gondii, like, does anyone ever just like, clear it all the way?

SEBASTIAN LOURIDO // We think that there's a statistical probability that over time, that kind of equilibrium breaks down and you have fewer and fewer of those chronic stages. And so eventually some people might cure it and or basically spontaneously cure it and some people might not in most of the experiments with, with mice. For instance, we see that, that the dose goes down, but there's still enough there that if you experimentally make the mouse immunocompromised, it comes back and kills, kills the host.

JVN // Oh, really?

SEBASTIAN LOURIDO // Yeah.

JVN // Scary. If you're, like, going through cancer or something and you've had it and you have to, like, have some treatment that makes you really immunocompromised. Like that's probably still dangerous.

SEBASTIAN LOURIDO // It is dangerous, it's particularly dangerous in transplants as well. There are actually different kind of levels of immunosuppression, right? And so it's not black and white and the kind of immunosuppression that you get from AIDS, the kind of immunosuppression that you get during transplant, those are very severe. And there's more intermediate forms that you would get from something like chemotherapy.

JVN // You know how, like, in Enough with J Lo, she fucking got that thing that knocks out cell service and then she fucking murdered him with her bare fucking hands. This bitch literally murdered his ass. It is the best fight scene ever. And I know we shouldn't murder people but like wow, it was, like, so good. So, like, his vulnerability was, like, cell service and not thinking that J. Lo would fucking kill his ass. But she did.

SEBASTIAN LOURIDO // Underestimated a Latina!

JVN // Don't ever underestimate, exactly! She got a fucking body double bitch gave her a wig. Fucking made him think that that other girl was her. Then she went out to the store the other way and she fucking that movie is so have you not? Why do you not? Do you? Are you not having seen Enough?

SEBASTIAN LOURIDO // I have not.

JVN // Your universal reward, for today—

SEBASTIAN LOURIDO // I am waiting to see where this metaphor is going

SEBASTIAN LOURIDO // fashion. You're what you got to learn today. And I'm so glad that we could do this. I'm so glad that you could teach us about your expertise so that I could teach you about Enough because it's such a—

SEBASTIAN LOURIDO // I have so much to learn, and flashlights up the butt.

JVN // Oh yeah, you did. No, that is flashlight asses and—but Enough, it's really good. You really need to watch, watch it. Like it is a little bit 2003 ish. But like, it's so good, like major wigs. Juliet Lewis is in it. That fucking guy from ER is in it. Like it's so good. Like you have to watch it yesterday enough. Please write it down. The vulnerability though. The vulnerability that the husband had was basically that he underestimated. So what's toxoplasma gondii's vulnerability? Like, have you found one? That's where the metaphor was.

SEBASTIAN LOURIDO // Got it. Ok. So bad news is that all of the drugs that we have against toxoplasma really hit the fast replicating phase. And so if someone has like acute toxoplasmosis and it is having, like, a lot of a symptoms from it, we can treat that and, and we have great ways of, of treating that, but we can't cure it because the chronic stages are resistant to all of those drugs. And so there's a lot of research sort of trying to figure out are there compounds that we can use as drugs that kill both stages and there are some promising leads in the research, but it's still in the kind of preclinical phase. On the other hand, we want to understand—and this is sort of like our job as basic researchers—what governs that switch? Like, what governs the, the ability of the parasites to turn from this fast replicating thing that we can kill to this very slow replicating thing that evades our immune response and we can no longer kill.

And so if we were to, to figure out what that switch is, could we turn it, right? Or could we prevent it from, from going on? And recently, actually, through some of the molecular studies that our lab has undertaken, we actually found what we call the "master regulator" of that event. And so this is a factor inside the parasite that is somehow responding to the signals that are causing it to transition. And it is both necessary for that transition. And it is also sufficient. If, if we artificially increase the activity of this factor, then boom, the parasites transition into that chronic state. And it's also necessary for maintaining the parasites in that chronic state. So if we disrupt it there, boom, the parasites come back into the acute active state that we can treat. And so the goal next is to sort of figure out, "How is that switch regulated?" so that we can design interventions that are going to either prevent the parasites from going into the chronic state or disrupt that thing while they're in the chronic state to bring them back into the treatable state and ultimately arrive at a curative therapy for toxoplasma.

JVN // Oh OK. So that's cool. Is there, do you ever think there's, like, a vaccine potential or like something to, like, make us like, not able to contract it in the first place or…

SEBASTIAN LOURIDO // There might be. Yeah. And actually there is, there's one vaccine that is used in animals and it's what we call a live attenuated vaccine. And so these are actually toxoplasma strains that in sheep are able to prevent infection with other strains of toxoplasma that would in sheep cause these epidemics of, of abortion, which are very damaging agriculturally for a flock, right, where you would have a bunch of pregnant sheep and all of a sudden they get toxoplasma and abort their fetuses. And so that's sort of the consequence of toxoplasma there. So preventing it with this live attenuated vaccine is one of the ways in which there, in a veterinary setting, it's controlled. Those are perhaps too dangerous for us. And so there have been no efforts to, like, translate that animal vaccine to something that we could use in humans.

JVN // Does that animal vaccine make it so that they can still have their babies?

SEBASTIAN LOURIDO // Yes! And safely without the risk of, of being reinfected?

JVN // Well, how come it's not too dangerous for the sheep?

SEBASTIAN LOURIDO // The thresholds for what's dangerous in a veterinary setting are different and, and also the cost of developing those things.

JVN // So if you're in a place like I remember when I went to the Philippines, there was just, like, 17 million cats everywhere, like there's just some places where there's just like way more cats, like, out there. And I feel like that, I bet you, like, lots of, like urban cats and like you living in close proximity to cats, like, would up a region's cases of toxoplasma? Like, I bet that's why it's higher in Europe. I bet that's why it's higher, like, because just wherever there's more, like, cats roaming around and, like, farms and shit. Like, my sister, she's got like 84 fucking million cats running around this goddamn farm. Because if you do, if you have, like, outdoor cats and they're just shitting places, it's not centralized to a litter box, then, like, random cat shit is just, like, like, that's actually kind of really dangerous. So how can people, like, take extra precautions? And what do you do if you suspect you've been infected? Like all you can do is, like, go to the doctor and then they would test you and then you'll just, like, have it forever. Really? Right.

SEBASTIAN LOURIDO // Yeah. And so the people who are treated are those who are developing symptoms, right? We talked about the ocular lesions that can happen in a subset of healthy individuals who acquire toxoplasma. And so those are treatable when they're acute and when they're causing inflammation, the problem there is that once you damage a piece of the retina, that's kind of just damaged. And so people will have to live for the rest of their lives with a hole in the retina. But beyond that, we would kind of just treat the symptoms and treat the acute stages of the parasites, there would be no cure. And then in most cases they'd get infected and you'd be fine. Maybe you wouldn't even know. Right. Like I had swollen lymph nodes when I was infected. And then my mom's a doctor, so I was getting, like, all sorts of tests, but some people might just be like, "Oh, I don't feel well," and then they clear it and it's fine. You've established this equilibrium with this parasite.

JVN // Hm. Ok. So what are the broader implications of your pathogen research in terms of like testing other parasitic infections, preventing a pandemic or other widespread health crisis? Like, improving our understanding of genome editing…

SEBASTIAN LOURIDO // We are really interested in the kind of molecular inner workings of these cells that have this remarkable ability to infect us to replicate, to subvert the immune response. And so our research is really centered on, on understanding that interface at a molecular level and sort of how it came to be, what are the adaptations, how are the genes expressed? How do you transform between different stages? Because these organisms do just remarkable things, right? We've been talking about their ability to infect us to find themselves in different cell types, to transform. And so part of our fascination is bringing that to kind of a contemporary understanding of cell biology and to implement all of the amazing tools that are around us, right and CRISPR and gene editing and proteomics and microscopy to understand these remarkable pathogens. There are also so I think a really interesting way of understanding that same cell biology in other related parasites. And so we had talked about the malaria parasites, These are close cousins of the malaria parasite. So sometimes even though they have their own adaptations, sometimes we're able to translate the knowledge that we're gaining from studying toxoplasma into the understanding of the infectious pathways in plasmodium. In in the malaria causing parasites. There are these other parasites that are found as intestinal pathogens that are common causes of diarrheal diseases that are particularly severe.

JVN // What's shigella? Is that what shigella is?

SEBASTIAN LOURIDO // Oh, shigella? Shigella!

JVN // Is that, that's the butt eating one that gay people are getting!

SEBASTIAN LOURIDO // Yeah, it's shigella flexneri, probably. That's a bacteria.

JVN // Oh, it's so yeah, but you do get it from eating ass. I hear.

SEBASTIAN LOURIDO // Yes. You know, another parasite you get is giardia!

JVN // Giardia! I heard of that one. I haven't had it but I've heard of it, you get that from eating ass, right? And, like, drinking shit water.

SEBASTIAN LOURIDO // Yeah. And that can actually exist as an environment pathogen. So you can actually get it from the shit water that originates from, like, other species. Sometimes they call it "beaver fever."

JVN // Yes, beaver fever! Because it happens in beavers.

SEBASTIAN LOURIDO // Yeah. And so those will kind of contaminate fresh waterways.

JVN // What about, like, parasitic STIs? So like she already has, like, one that you could get, that's like a parasitic ST I because you couldn't get it from eating butt. Is there any other ones?

SEBASTIAN LOURIDO // There is a, a kind of really interesting, very kind of ancient group of parasites called trichomoniasis vaginalis. And that one really only lives within the, the mucosa of the urogenital tract. And so that will be transmitted through sexual intercourse between different people.

JVN // But it only really lives in vaginal tissue?

SEBASTIAN LOURIDO // No, that's just the species name. I think that that's sort of, like, where—

JVN // Oh, like, butt and vagina tissue, it can live in everybody's tissue.

SEBASTIAN LOURIDO // Yeah, and in kind of penile tissue or the urethra, right?

JVN // Oh, I bet I totally have that one! Do most people have that one because it's ancient, like, are we all out here with that one or no?

SEBASTIAN LOURIDO // No. Although it is a surprisingly common STI.

JVN // What's it called again?

SEBASTIAN LOURIDO // Trichomoniasis vaginalis.

JVN // I gotta write that down. Honey, trichonomis vagina. Vag—what's that second word again?

SEBASTIAN LOURIDO // Vaginalis.

JVN // Vaginalis, honey! You've taught me so many amazing words today. OK, I didn't mean to—

SEBASTIAN LOURIDO // So yeah, trichomoniasis is interesting. It, it kind of lives in very specific environments. It, it is kind of like this flagellated thing but then it'll attach to the surface of the track and then kind of start eating up little bits of, of the track. This is all microscopic and So what people will have as symptoms are maybe kind of inflammation in the region, like, itching and it, it is pretty self contained to, to that mucosa. And so it

doesn't go all over the place. In some STI clinics, they claim that it can be, like, 25% of individuals. So it can reach, in certain populations, pretty high levels of infection. And of course, having an inflamed vaginal tissue or an inflamed genital area can then place you at risk for other infections. And so it can also…

JVN // Yes, yes, the way that your hand went like this and then it went like that, it was like scary, like, about, like, the way that you, like, hand acted. That, that was amazing. Ok. So now we're heading into our wrap up. So we want to hear more about the Loudiro Lab. So how many Teagan particles do you think are in the lab right now? Can I guess, first? Like 5 million.

SEBASTIAN LOURIDO // Oh, many more!

JVN // Ah, 100 million? A billion? more?

SEBASTIAN LOURIDO // Probably several billion!

JVN // Wow. Wow. So do you guys just, like, really, like, all wash your hands, like, like, super a lot?

SEBASTIAN LOURIDO // Well, these organisms and just, we maintain them and their very careful conditions, under strict containment. And so we have specialized designated rooms that have access control and all sorts of different features. They also have hoods where people can kind of like work with gloves under specific conditions and kind of maintain anything sterile and prevent themselves from, from getting infected. So there's all sorts of, of sort of safety that's required in order to work with anything that is human infective. And we categorize those along different levels. Toxoplasma would be a biosafety level two agent, which is one that we can still treat, that doesn't cause significant disease. And then there would be BL 3 and BL 4 as the kind of final stage of containment.

JVN // Ebola is a virus, right?

SEBASTIAN LOURIDO // Yeah.

JVN // Yeah, so, Ebola is not a parasite.

SEBASTIAN LOURIDO // No. And that would be like a BL 4 agent.

JVN // So the BL 4 and BL 3 designation applies to, like, viruses, bacteria, parasites, like, anything that scientists handle that, like, could infect people?

SEBASTIAN LOURIDO // That's dangerous to us or, or other organisms. Yeah. And so those are kind of different ways in which we place restrictions on how we work on the agents, but also engineering controls to make sure that there is no risk of, of it spreading. And so in the case of toxoplasma, we we keep a lot of kind of careful tabs on, on how we work on these organisms in order to keep everyone in the lab safe and of course, keep the community safe.

JVN // Does everyone in the lab have to get tested to see if they already had it?

SEBASTIAN LOURIDO // We do offer that. And because there are these tests when they enter the lab, they get tested also the stages with which we work are those acute stages. And so you would kind of literally have to either inject them in or they splash them into your eyes or something in order to be infected.

JVN // Oh no!

SEBASTIAN LOURIDO // And so we have fortunately had no such, no such incidents.

JVN // So there are other labs that study the chronic phase?

SEBASTIAN LOURIDO // Yeah. And we do, too. The most infectious form would be the of the stuff that happens in the cats and there you would actually have to have infected in.

JVN // Yeah. Yeah. So you were just, like, minding your own business and, and you said your mom was a doctor and then we were also reading that you studied like printing and print making in college like, but then you were just like, honey, I'm gonna study parasites and become like a fucking scientist. I know. Well, I, I kind of did both as an undergrad. I had these wonderful art teachers and I love the kind of creativity of, of that space particularly kind of shout out to my printmaking teacher, Teresa Cole who's still out and practicing. She's an amazing printmaker artists and, and teacher and, and I just was fascinated by all of these different techniques of production and how you could kind of like use them. There's also various elements of design. And then in the meantime, my mom was, like, "Well, you need a real career." And so I kind of was studying cell biology.

And I, I did like science and started working in a lab with, with viruses and, and kind of learning more about host pathogen interactions and becoming really fascinated with it. And when I was graduating, I kind of felt like, I don't know, in the art world, you have to be kind of, like, constantly selling yourself and talking about all of this stuff and it's not really about the work that you're doing. And so I, I kind of decided to become a scientist and now I find myself selling myself and talking all the time about the work that I'm doing. So that didn't end up quite as planned. But then that took me to Berlin where I worked in the laboratory of Arturo Zychlinsky at the Max Planck Institute for Infection Biology. And that was just such an education I actually worked on, on and salmonella to kind of diarrheal pathogens and their interactions with host cells. And I just became super fascinated.

JVN // I can't believe that I learned that it was shigella and not shigella, I've been calling it shigella this whole time.

SEBASTIAN LOURIDO // You know, I say tomato, you say tomato?

JVN // No, you were right! It's so, how do I say it?

SEBASTIAN LOURIDO // Shigella.

JVN // Shigella and salmonella, which, like, we have chickens in our backyard and I'm always like, really paranoid that we're gonna get salmonella.

SEBASTIAN LOURIDO // Just cook those eggs and wash your hands.

JVN // Yeah, we wash our hands because, like, yesterday, I was, like, picking them up with my bare hands and then I was, and I had my top off and I was, like, carrying them up, like, this because there were, like, 13. And then when I was washing my hands at the sink, I literally, like, was like washing my, like to, I was, like, scared there's, like, salmonella shorts and then my, my friend walked in and she was, like, "Are you scrubbing in for surgery?" I was, like, like all my forearms, like, everywhere with this because there's, like, chicken shit on the eggs.

SEBASTIAN LOURIDO // Yeah. And I think that, that, that can be a source of transmission. But you kind of need quite a bit of salmonella in order to infect a person.

JVN // Mmmm. So I need, like, a pile of chicken shit.

SEBASTIAN LOURIDO // Or usually, like, something with, like, raw egg that's just incubating there at room temperature or just, you know, like this is where people get it from

like a potato salad or something like that because it's like sitting out and the bacteria are just like growing like crazy inside of this.

JVN // Do people put raw eggs in potato salad?

SEBASTIAN LOURIDO // In mayonnaise, if they make their own mayo!

JVN // Ooooh!

SEBASTIAN LOURIDO // I know, we'll have an aioli recipe in the show notes!

JVN // I am. Yeah, I am definitely not going to make mayonnaise out of our eggs. Like, we definitely just do, like, cooked eggs, like, just, like, cooked eggs.

SEBASTIAN LOURIDO // But you can pasteurize it right? Like you can parboil it, a little bit.

JVN // Oh, and then make your own mayonnaise and it's more safe?

SEBASTIAN LOURIDO // I love cooking, too. So, anyway, so there are ways of, of getting around it. But salmonella is not a parasite. It's a bacteria.

JVN // Yeah, no, for sure, for sure. But you were just saying you studied it now. I have, like, a lot of questions on salmonella. I'm sorry. No, I'm focusing. So, what advice do you have for people who want to pursue the sciences?

SEBASTIAN LOURIDO // You don't want to know the rest of my story. It doesn't end in Berlin!

JVN // Oh, no, we have—Sebastian, thank you so much. So, you're in Berlin, you're saying the interactions between fucking shigella and goddamn fucking salmonella. And then what happens.

SEBASTIAN LOURIDO // And then I go and do my PhD in Saint Louis. So another connection.

JVN // And then you wind up there?

SEBASTIAN LOURIDO // I know, at WashU, they have a great microbiology program. That was awesome. Yeah, it was, it was a wonderful experience and, and honestly, I was like, I don't know what I want to do. I like bacteria. I used to do viruses and I decided to like rotate, we get to rotate to figure out which lab we're ultimately going to join as phd student. And, and I got to rotate it like all three. I like, like a virologist, a bacteriologist and I'm like, "Just to round it off, let's do a parasitologist." And I started looking at these things under the microscope and sort of seeing how they replicate and burst out of cells and invade. And I'm like, OK, this, this is what I'm gonna do from now on. And then after that, I moved to the Whitehead Institute, I started my lab right after graduate school as a fellow and then became a faculty member at MIT. And the rest is history.

JVN // So is that how it works? Like, once you, like, get your phd, like the goal is to like, go start your own lab. Like, that's, like, the ultimate goal of, like, most scientists, like…

SEBASTIAN LOURIDO // Not necessarily, there's just so much stuff that you can do with a PhD these days, right? Like you can work in science communication or you could work at a scientific journal or you could go into biotech or you could go into patent law, there's really kind of a lot of possible career options and one of them happens to be kind of continuing within that academic environment as a postdoc or as a researcher or, or part of the faculty, if you, like, to train people.

JVN // Ah! Sebastian, I'm obsessed. OK. So now that next question—and thank you so much for before. I was like, I'm obsessed with you. Like, literally you're, like, top 1% of favorite guests of all time. Like, I'm obsessed. So what advice do you have for people who want to pursue the sciences?

SEBASTIAN LOURIDO // I would say that you have to find your passion, right? Like in so many other professions, I mean, I think science is a creative profession and one where you get a ton of disappointment, you get a ton of frustration. But then you get these moments of pure joy and discovery and in that sense, it only works out when you are really committed to what's in front of you and you're ultimately kind of, like, enjoying that process. Right? So I would say that if, if someone likes the kinds of things that you do in science and if they're curious and if they want to know more and they find that by reading, they're just not finding the answers that they want to get and there's not enough then go into science and figure it out for yourself.

JVN // Ah! OK. So then what's next for you and your work?

SEBASTIAN LOURIDO // That's an excellent question. I mean, I think for us really, it's starting to become less about finding the individual pieces, right? I, I talked about the master regulator and we've found some pieces that are involved in invasion and we've done these kind of global analyses that tell us what parts are important and which ones aren't and to start integrating that across different levels of biology. And so we have the cellular level where these pieces are kind of coming together in very precise manners. But also the impact of all of those associations on the greater process of infection and how the parasites behave, how they differentiate and then when that happens, how that happens and how it's regulated in an entire infected organism. So how you have these essentially stories build up from the molecular level where chemical interactions are underpinning how things are arranged all the way to what we observe in an individual getting sick and the interactions with the immune system.

So I really like putting together those stories and sort of thinking about overall the evolution of how these things came to be, how the specific adaptations that allow parasites to infect host cells, how they occur. And so I want us to, to be able to kind of continue working with these ever improving technologies to get a better and better picture of how these organisms do. The incredible things that they do. Along the way, there are so many different opportunities to figure out interventions or to inform the work of other parasitologists and other organisms that are related to toxoplasma, but maybe even to uncover new features of our immune response and how we deal with these kinds of infections. I think those are all fascinating potentials of this ongoing work to figure out how toxoplasma does its thing.

JVN // I mean, Sebastian, if you'll, like, continue to work with us in future, I don't know if you knew that this was an audition to be, like, our resident parasitologist who, like, is, like, our just, like, go to expert on all things parasitology. But when you, like, find another cool thing, please come tell us about it. Like, I'm just so obsessed with you.

SEBASTIAN LOURIDO // Anytime!

JVN // I feel like I love you so much. I love talking to you. I know we're actually launching a new, like support series to getting curious, which is like, curious now that's gonna cover more like, topical things. But like, if you ever like, uncover some cool thing about like toxoplasma or if there's, like, some like funding or like science world academia issue that's like in the news that like you, that affects you in a particular kind of way that's not even within like, you know, parasitology necessarily, but, like, we would just, I just adore you. You're amazing.

SEBASTIAN LOURIDO // Let me know I would be so happy to participate.

JVN // Sebastian, thank you so much for coming on. You taught us so many things about parasitology, parasites. Toxoplasma. Nigella Lawson. Never knew I was gonna learn about her, honey. I'm just kidding. Um Everyone because it's not Nigella.

SEBASTIAN LOURIDO // And J Lo!

JVN // J Lo! Enough, that's your homework. You really remembered. And then when you discover the magic that is enough, let us know how much you loved it because it's, it really is special. So you're amazing. Thank you for coming on Getting Curious. Thank you, Sebastian.

SEBASTIAN LOURIDO // Thank you for the opportunity, Jonathan. Really, an amazing interview.

JVN // Ah!