Sodium, Iron, Magnesium, Nickel... Why Metals Are So Important – Lab 61

Titi Last week we had Dr. Snowden on the show, and she talked to us all about nuclear energy, and it feels like it was right on time because those gas prices had just skyrocketed. So we need to continue focusing on natural resources and ways to power our lives.

Zakiya Yeah, and I thought, OK, we got that under control. I feel like I know what's going on with energy. But then it felt like all along my timeline, all in the news, another natural resource that I hadn't considered was popping up. NASA's talking about making a new alloy. Biden was talking about the infrastructure plan only using U.S. steel. And I was like, Do we have enough of that? Where's the steel coming from? Is Pittsburgh still doing that? I'm concerned. And then not only is Elon Musk talking about buying Twitter, Tesla is also in the news for using manganese as the metal in their new battery cell. They're trying to work on.

Titi I'm Titi.

Zakiya And I'm Zakiya.

Titi And from Spotify, this is dope labs.

Zakiya Welcome to Dope Labs podcast, a weekly podcast that mixes hardcore science, pop culture and a healthy dose of friendship.

Titi There's a lot of conversation about natural resources and we see those gas prices skyrocketing and some folks are saying we should pay closer attention to metals.

Zakiya Yeah. Mercury in tuna, mercury in retrograde, nickels nowhere to be found. I mean, it's all bad.

Titi So this week we're talking all about metals. We're figuring out what constitutes a metal. So how is it classified and where we see metals and not just in the stuff that we use in day to day that we know about, but some of the ways that metals are used that we don't know about.

Zakiya All right, let's get into the recitation.

Titi So what do we know?

Zakiya Well, I think the concern about metals isn't new. I remember when people were stealing like copper pipes. Do you remember that?

Titi I do remember that.

Zakiya Which told me something was up with at least copper.

Titi Right? Is it because copper is expensive? People feel like they can resell it. You know, there were just so many questions swirling around that, but it was a very interesting time to be alive. I think another thing that we know is that metal is important, that we need it for a lot of different things in our tech, in a lot of engineering applications and in biological applications. So, what do we want to know?

Zakiya I know. I want to know--when we consider all of this stuff like you just said, the gas prices going up, considering our natural resources and what's going on with the planet--metals are coming out of the Earth. So, how are we looking on metals? Are we on track? Do we need to cut back? You know, where are we?

Titi What I want to know is more of the biology side of metals, because I think I understand metals when it comes to engineering and structures and the importance there. But I don't really know metals when it comes to biology, so I'll be really interested to hear more about that.

Zakiya And I think even though I know the metals are important for a technology, then what like, are we subbing them out? Are we using a variety of metals? Are there some metals that we just always use for tech stuff like where are we on that?

Titi OK, let's jump int the disection.

Zakiya Our guest for today's episode is Dr. Kate Buettner. Kate is a friend of the show and our friend in real life.

Dr. Kate Buettner I'm Kate Buettner. I am a bioinorganic chemist in the chemistry department at Gettysburg College.

Titi OK, so first things first, what is an inorganic chemist? I know when we hear the word organic, we usually think like Whole Foods, but this type of inorganic has to do with the makeup of a chemical compound. So organic means carbon based compounds and inorganic is non carbon based compounds. Kate is an inorganic chemist who focuses on metals. So we asked her to help us understand how common metals are, why we should care about them, and what are the defining features of metals.

Dr. Kate Buettner When you generally are thinking about metals, you're thinking about probably metals in bulk.

Zakiya What Kate means when she says in bulk is that when we're interacting with metals in our day to day lives like jewelry, cutlery and appliances, we're seeing the end product of a compound that was once very, very tiny. So the gold we see in Jay Z's grill looks different.

Titi Well, you can have pure gold in your grill. But for other metals like steel, steel is not something that you just, you know, open up the ground and you find steel, steel is actually

iron that's been treated with carbon to get this really strong material. So steel is an alloy, not just one singular metal. An alloy is a combination of two metals to create another. When we're talking about alloys, that's usually in the book, that's how we get steel, sterling, silver and a lot of the different metal compositions that we know and love today. But on the opposite end of that spectrum are really, really tiny particles like nanoparticles. I worked with nanoparticles when I was in graduate school and when I was working with nanoparticle gold, at that scale, when the gold particles are so tiny, when it's suspended in a liquid, it almost gives this pinkish purple color. So from nanoparticle to bulk materials that we're using, the physical properties can change in the way that we interact with those properties could change as well.

Zakiya I think there are other examples of metals behaving in ways that we aren't aware of.

Dr. Kate Buettner So those are things like sodium, which if you're thinking about sodium metal and you take a hunk of sodium metal and throw it in water, it will catch on fire.

Titi That reminds me of Lab 027, here comes the boom, where we talked all about fireworks. So sodium is one of the elements that's used in fireworks to help give them their color. Sodium makes orange, copper makes green. Strontium makes red. So it all makes sense.

Dr. Kate Buettner But sodium is everywhere. It's your table salt. So you have sodium and potassium that you're eating every day and are important for you living.

Titi Did you know that sodium and potassium are metals?

Zakiya You know, it makes sense based on what we know about the periodic table, but I don't think of them in that form. From a biological perspective, I think of them always in a compound with some other element like sodium and chloride giving me sodium chloride, which is salt. You know, so did I know, is it buried somewhere deep in my head? I don't think of it that way.

Titi Well, no, our cereal is not catching on fire, so we know it's very, very different.

Zakiya When I think about metals, I'm thinking about steel and titanium and copper, and I'm thinking back to those early principles I learned that probably are the most primitive concepts in materials science. I know, you know, way better than me, Titi. And I think, you know, I haven't had to look back and think about the periodic table in this way. So I didn't really appreciate just how many metals are in it.

Titi On the periodic table, metals make up over two thirds of the elements.

Zakiya So now we understand a little bit more about what metals are. Now we want to talk about where they are.

Dr. Kate Buettner There's different levels of abundance in the Earth's crust versus in the water versus in the human body, because different elements are differently stabilized in different environments. And so they're going to be in lower concentrations in the oceans versus in the Earth's crust. And so lots of the metals that we find are in mineral forms, in lots of the rocks and minerals that are everywhere. And so if you look at what elements are most abundant, iron is the most abundant thing that you probably think of as a metal.

Titanium is also quite abundant. Just one of the reasons that we try to use it. And so iron and titanium are the most common. There's also lots of magnesium and calcium and sodium potassium, and there's also lots of aluminum.

Zakiya The two most abundant elements in the Earth's crust are oxygen and silicon. So oxygen makes up about forty six point one percent and silicon is 28.2%. But those aren't metals. Silicon has some metallic properties, but not real real metals. It's a semiconductor.

Zakiya That makes so much sense when we think about it. Semiconductor? Partially conducting. Semiconductor materials are elements that are partially conducting.

Zakiya So when you hear the word semiconductor, that means that they are using those specific materials in that device. The most abundant metal found in the Earth's crust is aluminum. That makes up 8.3 percent iron is five point six, three percent, and it's the most mined because it's essential for steel production. Calcium is 4.1 five percent, magnesium is two point three three percent, potassium is two point zero nine percent and titanium is point five six five percent. And the rest of the metals, they make up 0.4 eight percent of the Earth's crust. And notice how we didn't say anything like gold, silver, copper, nickel, platinum or any of those other precious metals. Precious metals are metals that are rare. They're naturally occurring, but they have high economic value as well. And that's because although they're the most sought after metals, they make up less than point zero three percent of the Earth's crust.

Zakiya Dr. Buettner explained that the abundance doesn't always correlate to what is most used, and metals are a nonrenewable resource. What we have is all we got.

Dr. Kate Buettner At some point we're going to run out of precious metals. So there are lots of research funds looking to move chemistry away from using precious metals and into using things like iron and titanium and vanadium.

Zakiya OK, so now that you've laid it out, you know, just looking for something shiny doesn't always indicate that it is metal. And the amount available to us is variable depending on which element we're talking about. But how do we know for sure that something is metallic?

Titi Well, one great way to figure out if something is metallic is using our handy dandy periodic table. Like we've said in previous episodes, the periodic table is not random. It's arranged in a very specific way, and an element's position on the periodic table can give us clues, and this holds true for metals. OK, so pull out your periodic table. Right now, we'll pause and wait for you to pull up a tab for you to look at it. OK, so you have your periodic table and going from the top right to the bottom left. There is an increase in metallic character of elements, so it goes from non metals in the top right. So that's helium, neon, argon and all them. Boron, silicon, germanium, arsenic and antimony are all what are called metalloids. Metalloids are in between conductive and non conductive, so we call them semiconductors, and you've probably heard that word before, but we'll talk about semiconductors more in an upcoming lab, so make sure you stay tuned. And as you get down to the bottom and left of the periodic table, everything to the left of the metalloids is a metal and the father left you go the more metallic character the element has.

Titi So, Titi, I feel like you've really helped me understand this, I'm looking at the periodic table. Everything to the right, those are like gases and other non metals. There's this diagonal stripe, and those are things that are in between nonmetal and metal. So, they're

semi, and you're calling those metalloids, and that's that diagonal stripe to the left of that stripe, which is the look of things on this periodic table, those are metals. And the more left you are, the further Beyonce pushed you, the more metallic character you have, and those metallic characters are being able to conduct electricity, being able to conduct heat, having a luster, so on and so on.

Titi Yeah, should we rename the periodic table to Beyonce's periodic table?

Zakiya Where was Sasha Fierce be on table? What happened to her? We haven't see her in so long.

Titi Beyoncé, as they bring her back.

Titi OK, so I feel like we have a really good grasp on what metal is and the different kinds of metals. So I think what we want to hit now is like, why should we care?

Titi Right, metals are used in every aspect of our lives, like, you just stop and look around you right now. You're likely touching or being touched by metal in some way. And metal has the ability to take on so many different forms, depending on the treatment. So like, you know, the metal that you might have in a button on your clothes is different from the metal in a soda can or different from the metal that's supporting a bridge. And it's all because of whatever chemical processes or heat treatments or anything in between that that metal is put through to give it those specific properties.

Dr. Kate Buettner When we think about metals that are important in technology, there are lots of different metals that are used in batteries, and there's also lots of metals used in catalytic converters in cars. And so that's a big push.

Titi So in your car, a catalytic converter converts toxins into less harmful byproducts like water vapor and carbon dioxide. And catalytic converters actually use three precious metals platinum, rhodium and palladium, which is why a lot of people get their catalytic converters stolen from their cars and why they're so expensive to replace. One application we want to draw attention to is tech, because a property unique to metals like Zakiya, you mentioned, is their electrical conductivity. The reason why metal conducts electricity so much better than non metals is because their electrons can move freely between atoms. So if you remember from last week's episode an atom, the nucleus is made up of neutrons and protons, and then spinning around that nucleus is electrons. And when metals, they can move all around and that's exactly what you need to create current, which is what we use for electricity. So those electrons are moving around and they provide power for light power for your computer, power for anything that requires electricity. You need electrons moving, and metals do that really well. And one of those metals that's commonly used is copper.

Dr. Kate Buettner And we know that copper is used for all sorts of things in like copper wire and for transport of electronics sort of stuff. And so those are really important in technology in ways that I very rarely think about.

Titi Also, aluminum and nickel are used in a lot of semiconductor chips and batteries. Now that Duracell copper top makes sense.

Titi Yeah, exactly. There's another part of the periodic table that we didn't talk about yet, but it's a great time to bring it back up. So, OK, go back to your tab that has the periodic

table. And if you look at the bottom, you should see two rows that are detached from the rest of the table, and those are called rare earth metals. And they're called this not just because there isn't a lot of them, but because they're extremely difficult to mine, but they're really great to use because they have these really great properties like they are used as catalysts. They're used in a lot of electrical and magnetic and luminescent devices.

Zakiya All those properties sound great and we've been using them. So when we think about the explosion of technology in general, the invention of the cell phone, the computer laptops over the last 20 years, I'm sure, would that explosion of products there has to have been an increasing demand on those elements?

Titi Exactly. And then rechargeable batteries, that's like a new thing relatively to, you know, our world rechargeable batteries are new and they are made with rare earth compounds. And so the demand for batteries that recharge goes up like as we have these new inventions like the cell phone and the computer and also with electrical vehicles. So, you know, now electric cars are becoming more and more of a thing. I've been seeing a lot more Teslas, a lot more hybrid cars on the road. Those batteries that are powering those electric cars are made of a lot of rare earths and nickel. And so they're super important to keep pushing us into this technological age, pushing us forward so we can move away from fossil fuels and use electricity to power our lives.

Zakiya This is such a good point, because now you know, it makes me think about this tradeoff. Just last week, we talked about nuclear energy with Dr. Snowden, and this is a perfect example of these types of tradeoffs. So on one hand, you're reducing the use of nonrenewables like gas and oil, but on the other hand, you're increasing the demand for rare earth metals to build the electric cars that we think are solving the other problem? Vicious, vicious cycle.

Titi Yeah, such a good point. Another downside to rare earth metals is that it's really difficult to get rare earths out of the Earth. And so it costs a lot of money and it's inefficient. And some of the byproducts of mining rare earths are toxic materials because you're also pulling up uranium, as you're pulling up these rare Earth metals that we want to use, and as we know from the nuclear episode, uranium is not something you really want to be around like that. Another issue with rare earths is that they're not only not abundant in the Earth's crust, but it's not like there's an even distribution of rare earths all over the Earth. Most rare earths are in China, and China produces about 90 percent of the supply, which means that they control the industry.

Zakiya So basically, there's no free lunch when it comes to Earth metals, they have all these great properties, but there are a lot of other aspects to kind of wade through when we're considering how we get them.

Titi It goes back to what Dr. Snowden was saying in the last episode is that there are risks to everything, and those are things that you just have to weigh out because it will help us if we're able to move towards using electricity to power our lives. But there are some tradeoffs that we're trying to reconcile so that we can make sure that the advances that we're making aren't biting us in the butt later.

Zakiya So considering the uneven distribution of metals, I would imagine that that uneven distribution is subject to a lot of our geopolitical influences in the world right now. And so I know recently, obviously and a lot about a nickel shortage in the news as we consider the

war between Russia and Ukraine. So we asked Kate to tell us what we need to know about nickel.

Dr. Kate Buettner I think the thing that loss of nickel is most worried about because it's used in batteries, nickel hydride batteries are used in cars. And so I think that's where the biggest worry comes from with a run on nickel supplies. There are lots of different places where there are nickel mines, right?

Zakiya So nickel is really, really important when we're thinking about batteries for electric vehicles and pretty much all batteries that are rechargeable. As the battery research advances, they want more and more nickel. In batteries, you have a cathode and annode. And the cathode at this point is about 80 percent nickel. And so we need nickel very badly.

Dr. Kate Buettner If you lose a significant percentage of that, then it's going to be a lot harder to keep making nickel hydride batteries at the level that's needed to keep producing cars.

Titi And this is a problem because Russia produces 20 percent of the world's highest purity nickel.

Zakiya So Russia invaded Ukraine on February 24th, 2022. And on that day, the cost of nickel per ton was twenty four thousand seven hundred sixteen dollars. Now that's twenty four thousand seven hundred sixteen dollars. Stay with me on March 8th. Now, remember, February only had twenty eight days, maybe on March 8th, 2022. Nickel was $80000 per ton. That's a big deal because as we advance with technology and the needs for electric vehicles, more and more nickel is required. And so the cost of nickel is so high, it may mean that the cost to manufacture the battery is super high. So now we're looking at access to electric vehicles, which can reduce other costs and can reduce other impacts being cost prohibitive, even more cost prohibitive than they already are.

Titi Right. So that electric car goes from being just a little bit expensive to only Bill Gates can afford it. OK, so Dr. Buettner has taken us through what metals are, where they are and what they're used for in tech. But when we come back, we're going to talk about metals in the biological space.

Zakiya We're back we're talking to Dr. Kate Buettner all about metals, but before we jump in next week, we're talking to you about maternal health with Simonne Taitt.

Titi Let's get back to the lab now that we have gotten the lowdown on metals in tech, Zakiya, you're going to have to hold my hand through metals in biology.

Zakiya You know, this is so interesting because when I think about this, you know, you blew my mind. You said, Hey, did you know sodium and potassium were metals? And I'm like, Oh, I think about sodium potassium so much from a biological perspective. And I think we have to level set. First, everybody should know we need metals in our body to live. And if you're a Dope Labs listener, you already know this. If we think back to our lab with Dr. Alice Lichtenstein, where she talked about nutrition and the vitamin and micronutrient requirements, we already knew that metals were important. So I think the first thing is understanding that sometimes metals get a bad rep in the biological context. And there's something I was reading from plant scientists, so the botanists are here informing us, and they're saying, Listen, you've really got to think about metals in context, too few metals that you have nutritional deficiencies, too many metals and then you have toxicity.

Titi I once accidentally swallowed a piece of aluminum foil when I was in summer camp.

Zakiya You're still here, so you were in the sweet spot of metal homeostasis.

Titi It was on my applesauce lid, and I was trying to open it with my mouth, and I pulled it off and then I just inhaled and it went down my throat and I think about that piece of aluminum pretty regularly.

Zakiya Well, the good news is that your body needs a lot of metals, OK?

Titi I was doing my body a favor. I ate the applesauce too.

Zakiya So now we understand that there is a concentration that we need of various different metals for us to have proper bodily function. And so even though nickel and these other metals are important for technology, they're also important for our bodies.

Titi OK, so where are we getting the metal from?

Zakiya That's a good question. And most of it is coming from our foods. Metals are in plants, metals are in other animals that eat plants, right? And in places where people aren't able to eat foods that are rich in metals, they often have to fortify foods. So metals are so important that we add them to our food products. So if you think about fortified cereals, raisin bran is an example. It has iron.

Titi Hmm. What about cocoa puffs?

Zakiya Probably not. I won't say that. I won't say that it's not good for you. I don't know that. I just know it has cocoa and that's not a metal.

Titi I'll check the periodic table.

Zakiya There are some metals that are super important from a nutritional perspective that we can think of immediately, like calcium, which is important for your teeth and bones, right? Iron, which is important for transporting oxygen, and we can talk about that in a little bit more detail. Magnesium, potassium, but you get those things. Calcium is naturally in yogurt and milk and fish and in juices that get fortified with calcium, right? Because they know kids are drinking juices and they need a lot of calcium as they are growing and building their teeth. And so we add calcium to the food product.

Dr. Kate Buettner You have lots of iron in your body that's carrying your oxygen around in proteins like hemoglobin and you guys talked about that in the episode on the impossible meats, where that color change is coming from that iron in your proteins and so that iron is really important because it's what's binding to oxygen and it's what's letting you have respiration. And so in biological systems, iron is very important, like we already talked about for transporting, and you have different proteins that very carefully control your iron and move your iron all throughout your body.

Zakiya Iron is very important for carrying oxygen. 70 percent of your body's iron is found in your red blood cells that are in your blood and in your muscles. So if you think about hemoglobin, that's iron carrying oxygen from your lungs to your various tissues in your body via blood. So via those red blood cells? And similarly, iron is involved in your

muscles, so myoglobin, it's accepting oxygen in the muscles and storing it. So it's super important for living because you need oxygen into all those tissues,.

Titi So is that part of the reason, maybe that when you are iron deficient, you might feel weak and lacking energy because your body's not getting all of that oxygen that the iron is supposed to be transporting all over your body?

Zakiya You got it.

Dr. Kate Buettner There are things like manganese that's really important in lots of different areas. And so manganese is important in creating oxygen in the oxygen evolving cluster in plants. When they're doing photosynthesis, you need metals to carry out photosynthesis.

Zakiya And I think that's really important. We've been talking about human health, but remember biological systems, that's across everything. So, plants need metals, too.

Dr. Kate Buettner There's things like calcium that you probably don't really think of in its metallic form, but it's a metal. And you know that that's really important in your bones and you have these calcium phosphate things for bio mineralization. So your biology is creating minerals to make your teeth and your bones, and to make shells for sea animals and all those sorts of things because crustaceans are important. And there's also things like zinc is really important in lots of different proteins, both to just hold the proteins in the form, the structure that they need to have, as well as to carry out catalytic reaction. So to make sure that all your biological processes can happen.

Zakiya And so now when we think about things that are really important, like the genome and we want to understand all the genes, there is a study of the metallome to understand how metals are distributed in different cellular compartments in the body in biological systems.

Titi I feel like our episode on vitamins and nutrients really gave me a peek into how important these vitamins are. But when we're thinking about them as metals and their role in our body, I had no idea that there was the metallome. So, now I have a lot more questions and one of them being if we have so much metal in our bodies that help us. Are there metals that are used for medicinal purposes?

Zakiya Yes. Metals have been used to treat disease for a long time. OK, well before what we consider, you know, modern western medicine. The Egyptian and Chinese doctors are like, Been there, done that. That's the first footnote. OK, moving forward in time, in the 18th and 19th centuries, we started seeing metals being used as anti-cancer drugs. And so we saw a big boom in this in the 60s in metal based cancer drugs that were based on some of the platinum group metals and platinum group metal complexes like cisplatin, carboplatin, oxaliplatin. And then we're starting to see other compounds like gold, titanium, copper, cobalt, the Nadiem. All of those are starting to get used or being explored as anti-cancer therapeutics. So to you really raised a good point, saying Kim metals be used to help us because we use them in our bodies, but because they're used in different biological systems, they're also being used by things that sometimes harm us. So you can almost weaponize metals against bacteria. Oh, really? Yeah. One of those metals that's really useful for this is silver.

Dr. Kate Buettner Silver is definitely known to have anti-microbial properties, and so it's in lots of clothing. There are studies that look at putting it in dental implants to keep. And so we do a lab and one of my classes using bacteria that Zakiya collected and studied to see how silver complexes can inhibit growth of bacteria. I know that silver is used as nanoparticles often, and so there are silver nanoparticles embedded in lots of fabrics now to try and make them not smell bad in your workout clothes when you have bacteria growing from lots of sweat.

Zakiya So Kate told us a lot about all these medals, but I learned from you more about metals in a technological context.

Titi Yeah, and I learned a lot about the biology from you.

Zakiya And even though I thought it was important only knowing half of the information, now I feel like we really got to get this medal thing figured out. And that's one of the things that Kate is working on in her lab, trying to figure out how we can leverage the medals that are actually more abundant. So that was our question. Is there some type of shift to rely on one metal versus another? Can we find good substitutes?

Dr. Kate Buettner There's a lot of push to move towards more abundant metals and more environmentally friendly metals. I think on industrial scales, that comes a little slower and it comes often from regulations requiring those things. And until those things exist industrially, that's less pushed for because they want to do the thing that's most efficient. And so using a costly metal isn't as big of a deal because they can find that money and do it. And so we work with specifically titanium and vanadium. And so what we're doing is looking at the ways that nature has protected iron and other hydrolysis prone metals from reacting with water and kept their reactivity. And so we want to use those same things to get the reactivity that we want from titanium and vanadium and protect them from unwanted reactions with water.

Zakiya And that feels so important. It's important in so many ways, like you were saying, we have to really consider this as we continue to think about advancing technologies and the things that we're currently relying on that need these rare metals.

Titi Yeah, because like we said earlier, all the metal we have is all the metal we've got people, so we've got to figure out a way to use it efficiently and not just efficiently, like, Oh, we're using a specific amount and it gets us the most output, but also getting it efficiently, selling it in a way that is efficient and cost efficient and everything in between because it's clear that metal is that girl.

Zakiya She's that girl.

Titi All right, y'all, it's time, for one thing. What is your one thing this week?

Zakiya My one thing this week is a new docu series about an NBA hopeful determined to take control of his journey to the NBA. It's called The Long Game: Bigger than Basketball, and it's on Apple TV plus.

Titi My one thing is also related to sports, and I'm not even really a huge sports fan. But it's Winning Time on HBO Max. It is so beautifully done it follows the story of Magic Johnson from when he graduated from Michigan State and started with the Lakers. It is art. It is seriously art. I really enjoy the production quality. Everything is just chef's kiss and

it really pulls you in. I love the storytelling. They're doing an awesome job and I am there every single week ready for the next episode. That's it for lab 061. What do you think? We love hearing from you. So make sure you give us a call at 202-567-7028, and tell us what you thought. Or you can call and tell us about a lab that you think that we should do. We love hearing from you, so give us a call at 202-567-7028. And don't forget, there's so much more for you to dig into on our website. There'll be a cheat sheet for today's lab, additional links and resources in the show notes. Plus, you can sign up for our newsletter. Check it out at dopelabspodcast.com! Special thanks to our friend and guest expert, Dr. Kate Buettner. You can follow Kate's lab on Twitter @buettnerlab.

Titi You can find us on Twitter and Instagram @DopeLabspodcast.

Zakiya And Titi's on Twitter and Instagram @dr_tsho.

Titi You can find Zakiya on Twitter and Instagram @zsaidso. Dope Labs is a Spotify original production from MEGAOHM Media Group.

Zakiya Our producers are Jenny Radelet Mast and Lydia Smith of Wave Runner Studios.

Titi Editing and Sound Design by Rob Marczak.

Zakiya Mixing by Hannis Brown.

Titi Original Music composed and produced by Taka Yasuzawa and AlexSugiura from Spotify. Creative producers Candice Manriquez Wrenn and Corinne Gilliard. Special thanks to Shirley Ramos, Yasmeen Afifi, Kimu Elolia, Teal Kratky and Brian Marquis.

Zakiya Executive producers for MegaOhm Media Group are us.

Titi Titi Shodiya.

Zakiya And Zakiya Watley.