Erin Welsh	Hi, I'm Erin Welsh and this is This Podcast Will Kill You. Welcome back everyone. I'm very excited that you're joining me for this latest bonus episode in our mini series of bonus episodes that have been coming out for the past few months. Just as a refresher, I'm putting together these bonus episodes as a way to hopefully accomplish two things at once. First I get to explore in more detail some aspect of what we cover the previous week, helped along by an expert guest of course. And second I get to then ask that guests all about their experiences in their career, what they like about it, how the field could be improved, any advice they may have for people interested in a career in public health or disease research or science communication and so much more. It's been such a fun journey so far and I'm especially looking forward to this week's episode which I think maybe our most electrifying yet.
	Last week Erin and I covered lightning strikes, especially what happens to your body if you are unfortunate enough to get in between lightning and the ground. And if you haven't listened to that episode yet you should definitely check it out before listening to this one because in it we cover a lot of the basics of lightning and some of electricity. And I think it will really help to provide a background for what we'll be talking about today, which is more about electricity. In our lightning episode we talked mostly about lightning, how it forms, the biological impacts of lightning on the body, and some differences between getting struck by lightning and getting electrocuted through other ways.
	But what we didn't really get into in any great detail was how electricity in general works. For example, what is voltage? What is amperage? What's resistance? What's the difference between them and why do they matter in understanding electricity? And also some of the other ways outside of getting struck by lightning that electricity and biology can intersect like fish species that can generate their own electricity for stunning prey or how modern electro therapy is done. And part of the reason why we didn't cover these things on our regular season episode was because we can't cover everything. We have to put at least some boundaries on how much we can talk about in a single episode. But it also comes down to the fact that the principles of electricity, they're complicated and they can be difficult to understand. And understanding them well enough to be able to explain them in an accessible way to someone else, now that takes a whole other kind of skill, one that my guest for this bonus episode has in abundance.
	Dr. Timothy Jorgensen might be a familiar name to you especially if you've listened to our radiation episode before which features a short interview with Dr. Jorgensen in which he walks us through exactly how radiation works. Or maybe you read his book 'Strange Glow' all about the science and history of radiation. Well as it turns out Dr. Jorgensen recently wrote another fantastic book called 'Spark' and this one is all about how electricity works, the ways in which our understanding of electricity has changed throughout history, what it has taught us about biology so far and what it could teach us in the future. So who better to bring on to help us gain a better understanding of the ins and outs of electricity? In this bonus episode, Dr. Jorgensen and I are going to explore amperage vs voltage, how the human body uses electricity, some of the modern applications of electro therapy and so much more.
	And since Dr. Jorgensen is such an accomplished science communicator, I wanted to take the opportunity to pick his brain on how you go about writing a book on such a wide topic and still manage to make it fun and accessible, ways in which grad and med school training could incorporate science communication, and advice for those interested in becoming science communicators. I am super excited to dive in. So we're just going to take a quick break here and then I'll let Dr. Jorgensen introduce himself.
TPWKY	(transition theme)

Timothy Jorgensen	My name is Tim Jorgensen. I'm a professor at Georgetown University, I direct a program in health physics and I am a professor in radiation medicine and also biochemistry in the medical school. And I've written two books that are targeted for a general audience, one is called 'Strange Glow: The Story of Radiation' and then my most recent book is 'Spark: The Life of Electricity and Electricity of Life'. And I'm happy to be here.
Erin Welsh	Well thank you so much for joining me today. I am really excited to ask you a bunch of questions about electricity. So I loved your latest book 'Spark' and I thought it was a fascinating and brilliant way to tell the story of electricity through this lens of biology. What made you want to write this book and how did you decide on the format that you used? How did you decide what to include or what not to include?
Timothy Jorgensen	So this book is an outgrowth of my previous ones. So I had written the previous book about radiation and in writing that book I had included an explanation of radiation but I also had mentioned some things about electricity. Scientists who work in radiation have one foot in the electrical world and one foot in the radiation world because the two disciplines are connected. And I had mentioned some things about electricity in those books, so I got some questions about electricity too. So the book was quite successful and the publisher was interested in me writing another book but I didn't want to write another radiation book. I thought I've said all I can say about radiation. So my wife said well people seem to be as interested in the electrical part as they are the radiation. Why don't you write something about electricity using the same style that you did for the radiation stories? And so I thought about that for a while and I thought that sounds like a pretty good idea.
	And the strategy of the book is you tell a human interest story, something that will get people interested in finding out what happens and usually something that happens in that story, something technical happens in the story. And you have to break the narrative of the story and explain to the reader the technical thing so they can keep following the story. And then you go a little further. I call it the Trojan horse strategy, by the end of the story they've learned about Helen of Troy but they've also learned about how to build a wooden horse as well. So the idea here is that the person will kind of absorb a lot of technical information passively. But also they'll remember that technical information because it's in the context of the story.
Erin Welsh	So there is so much ground that we could cover here in our discussion of electricity and so many different aspects that we could focus on. But if we're going to talk about even just one area of electricity, it's probably best to get a baseline for how electricity actually works. In our episode last week, Erin went through the basics of how lightning forms but can we get even more general? Can you explain what exactly electricity is and what the difference is between voltage, amperage, and resistance?
Timothy Jorgensen	So electricity, as we now know, which was not known when it was first discovered, electricity is the flow of electrons. Atoms have a nucleus and they have a cloud of electrons around them. And some atoms hold onto those electrons very tightly but others like metals have a very loose grip on some of the outer electrons. And so they can jump from atom to atom. And when you get a flow of these electrons going in a particular direction for some reason, that's an electrical current. So some things are good at shuffling electrons down to the next guy and those are conductors like copper wires are good. And other things like wood and plastic are not so good with moving their electrons along and so those are insulators.

	And rather than just categorize things in terms of insulators and conductors, we could think of things as everything has some potential to be a conductor but some are bad conductors and some are good conductors and the reason that they are bad is because they have a property called resistance. So resistance is just as it means, it's resistant to the flow of electrons. Now a lot of people like to describe electricity in terms of a flow of water cause for historical reasons people thought that electricity was a fluid. And so it made sense to describe things as a flow of this invisible fluid.
	So if we wanted to make an analogy with water and we wanted to make that analogy with a garden hose for example, the voltage would be the pressure at the tap. So if you have good pressure, you know it when you open the tap, the water comes out very forcefully. That's the voltage. If you have low pressure, the water just kind of dribbles out. The amperage is the representation of how much water flows out per unit time. So how many buckets you can fill up a minute. That's the amperage. And if you if you had to describe the resistance, you could say that as you turn the valve and you start to close it, you start making the hole smaller and smaller for the water to pass through, you increase the resistance to eventually at the point you shut it off. So if you wanted to compare electricity to water, I think that's a good analogy, a water faucet in the flow from the flow of water.
Erin Welsh	And so what influences each of these principles of electricity?
Timothy Jorgensen	The reason that electricity flows is because there is an over abundance of charge. There are more electrons in one place than there are in another place. And so the electrons, because they're all the same charge, they repel one another and they want to spread out. And so if there is a place that they can go to where there is less of a density of electrons, that's where they will go, that's how things start. So for example, the earliest electricity that we knew about was static electricity. And people produced static electricity by rubbing two materials together. It started out with rubbing amber with wool. So what's happening there is when you rub these two things together, the electrons from one thing are being scraped off and moving on to the other thing. With wool and amber, that transfer is extreme and so now the charge builds up and the electrons on the amber will now try to jump to the wool and that's basically what's going on.
	And it doesn't have to be amber and wool, amber was hard to find and expensive. So people found out that if you rub glass with silk, you got the same thing. And so the first generators of electricity were simply to to make a glass sphere with a crank on it, attached a silk pad so it rubbed, turn it as fast as you could, and then bleed the electricity off of the glass. The first generators of electricity, were really static electricity machines that worked just by rubbing things together.
Erin Welsh	So you mentioned that there are bad conductors and good conductors. What makes something a good or bad conductor? Like why? Why is would a bad conductor vs copper wire?
Timothy Jorgensen	So most of the good conductors are metals and it has to do with how available the electrons are to move. So the electrons that are closer to the center are very tightly bound but if they have a cloud of electrons and some in the outermost shell, they're only weakly attached. And if these atoms are right next to each other as they are in metal, they're set in almost like a lattice form. It's very easy for these electrons to just move to their next neighbor. And so electrons can just flow, particularly if they're being pushed by excess charge on one end, they'll just push down and the charge will just move to the other end. Things like plastics, they don't have these weakly held electrons, most of their bonds are covalent bonds that are not involving these weakly charged electrons. And so they tend not to conduct electricity.

Erin Welsh	Can you walk me through the difference between direct current and alternating current? And what are some of the practical implications of the difference between the two and how are they used in different settings?
Timothy Jorgensen	The story of alternating current and direct current is a very interesting one because it involved a war between Edison and Westinghouse about which type of current was going to be the standard for the United States for power transmission. As most people know, Westinghouse won that war and all of our household current now is alternating current. So what is it? So direct current is when the electrons are moving in one direction only. And in alternating current, they move in one direction and then they moved back in the other direction. And they do this very fast, 60 times a second. And they're both electric currents but they have some advantages. The alternating current has a tremendous advantage in terms of being able to transmit power great distances. And the reason for that, the simple explanation is that the easiest way to transmit power great distances is at high voltage.
	You can transmit both types of power, direct current and alternating current at high voltage. And when I say the best way, the way that loses the least energy to heat, you don't want to produce a lot of heat. All that heat is just wasted energy. So you do it at high voltage because the only other alternative, low voltage, you have to push it with so much amperage and amperage is what drives the heat. You can do both of them, both types of current can go at high voltage. The problem at Edison's time was that you don't want to bring high voltage into the house. Nothing in your house can use this very high voltage, it has to be stepped down. And there was a way to step down alternating current at the point of use with local transformers. But there was no way at that time to step down direct current.
	So if you wanted to use direct current in your house, it had to be transmitted at low voltage. And that caused a lot of problems and it was not possible to transmit it more than a mile that way. But if you used alternating current, you could transmit it at high voltage very efficiently and then drop it down to appropriate voltage for household use when it got to its location. So this is what the basis of the war was. And so it lives with us to this day. Interestingly enough in the 1940s I believe someone invented a way to step down direct current. And so it wouldn't be such a big issue today but we live with the legacy of the technology of that period.
Erin Welsh	How do these principles of electricity, amperage, voltage, resistance, and the type of current, how do those things relate to the overall risk of injury or the severity of injury for humans if someone comes into contact with electricity?
Timothy Jorgensen	To oversimplify things, voltage is what causes the pain. If you want to make a fence, electric fence to keep a bear out of your yard, you want something that has very high voltage but very low amperage. It's the amperage that kills, not the voltage. So things like tasers and electric fences and even static electricity shocks that you get by rubbing your feet on the carpet, this can be like 50,000 volts and you feel it. Why don't you ever die from a carpet shock? Because even though the voltage is very high, the amperage is very low. So you need amperage to kill. You can even make electricity less damaging by interrupting the current flow, interrupting the amperage, and that's how it works on an electric fence. Okay so alternating vs direct current danger. The truth is that they're both equally dangerous and they're different enough that an all else being equal comparison isn't possible. But it doesn't really make much difference because they're both dangerous and they should both be respected equally.
Erin Welsh	So in our discussion so far and also in last week's episode, we have largely been talking about electricity in general or what happens when someone comes into contact with electricity. But now I want to shift to talking about some of the ways that humans and other animals interact with electricity. So how does the human body use electricity?

Timothy Jorgensen	The chief use of electricity in the body is to operate the nervous system. And in 'Spark' what I tried to show is that neuroscience and electrical science developed together. The first ways of detecting electricity were feeling it, getting shocks like from amber, or getting it to have some effect on a living thing. And frog legs were very, very popular. If you touch something and the frog leg moved, then you knew that it had electricity in it. It's because the electricity has the ability to stimulate muscles and nerves that it causes that kind of movement. So during the course of history, people used the effects on the body, either animals or human bodies, to measure and detect electricity. And likewise people used electricity to figure out what was going on in the human body. So these two sciences kind of leapfrogged over one another and when there was an advance in electricity, it allowed further advances in neuroscience. And when there was an advance in neuroscience, it told us more about electricity.
	And this is basically the understanding to this day. It comes right up to the point now where we're implanting computer chips in brains to electrically stimulate different areas of the brain in an attempt to cure diseases or power artificial limbs with thoughts. And so we've come to the point where we now have brain machine interfaces that convert electrical signals into neurological signals and vice versa. And that has all been aided by knowledge about electricity but also knowledge about computers and also an exploitation of the fact that our nervous system works kind of like a computer and that it sends binary signals.
	So when you shock a nerve, the amount that it shocked doesn't go up and slowly down. It sends out a bunch of signals called action potentials or what are commonly known among neuroscience as spikes. And so if it wants a bigger signal, it sends more spikes which is very analogous to what a computer does with its binary language, it's on or off, on or off. Nerves are sending signals or not, on or off, on or off. And so this is conducive to these two systems being merged together through these brain machine interfaces that actually work both ways. You can write information from the computer now into the brain, activating particular cells, and the same interface can pick up electrical signals from those cells and tell the computer what the brain is doing. So this is something that started out with shocking yourself with static electricity and frog legs and right up to this day we're looking at brain machine interfaces and how they can be used to alleviate disease and pain and suffering.
Erin Welsh	I want to talk a little bit more about some of these modern applications of electrotherapy. What do we know about why or how these modern therapies are effective in treating things like epilepsy, certain types of depression, and Parkinson's disease?
Timothy Jorgensen	So deep brain stimulation is used primarily for Parkinson's disease. Parkinson's disease is a disease where people have tremors in their hands or legs and these can be quite severe. And there was a surgery that partially relieved this for people. There's a part of the brain deep in the brain and physicians found that if you ablated, you removed one half, one side of this brain part, that you could relieve the tremors on the other side of the body. So you couldn't do both sides of the body because you couldn't eliminate the organ entirely because that would cause all kinds of other problems. But they could give people relief on at least one side of their body using this technique. And they were using electric probes during the surgery to try to stimulate and find this particular tissue that they were going to cut out. And when they used the probe, they found out that using the probe alone eliminated the tremors.
	So the next thought was maybe we don't have to cut this out, maybe we can just stimulate it and eliminate the tremors by permanently planting an electrode in it. And that way we could control how much electricity, we control how much we're going to reduce the tremors, and we can remove it in the future if it presents a problem and the patient is no worse for wear. So electrical stimulation for treatment of Parkinson's with these deep brain stimulation became a panacea basically.

	And now there are many, many people who are benefiting from this and it definitely works. The person had tremors and now they don't have tremors. Exactly why it works is up to debate but it definitely works. And there are other similar stories for treating depression for example with electroconvulsive therapy, that also works. And so more and more diseases are being treated now. Epilepsy is being treated with electrodes on the vagus nerve. And these things work and they've been shown to work by a randomized clinical trial. But we don't really know exactly, there are many theories and we're getting closer and closer to a better understanding of how the nervous system works by using these therapies, but nobody really understands how they work.
Erin Welsh	Like you said in your book, electricity has taught us so much about how the human body works. And in a similar way several animals have revealed a great deal about how electricity works. For example, one of my favorite stories of electricity involves Volta finding inspiration in the torpedo fish to design this first true battery, which is the story that I told in the episode last week. But what I didn't go into was how exactly these fish generate electricity. So would you mind walking us through that?
Timothy Jorgensen	So these fish generate electricity very similar to the way our neurons do. And as opposed to rubbing things and getting static electricity that way or in a battery, you have an electrochemical reaction that's generating the electricity. In a neuron, neurons do it a little differently. What they do is they take charged ions, ions are molecules that in solution that are either positively negatively charged. What neurons do is they are able to pump these ions from inside to outside. What they do is they produce a charge differential between the inside and the outside by pumping ions in, probably positively charged ions in, and pumping them out. And what they do is they make a difference in charge between the inside and the outside. And as I said earlier, whenever you have a difference in charge there's a potential for electrical flow.
	And so what happens is the neuron is able to open up gates to release all this charge that it has previously segregated and that institutes an electrical signal which stimulates the next neuron to do the same, the next neuron to do the same, the next. And that's basically how our nervous system transmits electrical signal by segregating charge and then releasing it. And these fish, you mentioned the torpedo fish, there are electric eels, they all do it the same way. They have an electrical organ that specifically is an overdeveloped part of their nervous system. These cells are specialized in doing this to extreme extents. And so these cells, they're called electrocytes, achieve huge voltages by doing this ion pumping thing and then the fish at will can release all that charge in one sudden burst to shock its prey. And that's basically how it's used.
	Now they don't have enough current to kill their prey, so generally what they do is they shock prey to stun it and then they attack. And that's how these fish do it. And it was the inspiration of these fish that caused Volta to investigate ways of making electricity, he wanted to make an artificial electric organ. When he did get something to work he thought he had discovered the way that that fish and make electricity but he had not, he had found a different way to make electricity and that's through electrochemical reactions. And so it's a fundamentally different process but the electric fish do something that's very much akin to what our everyday cells do.
Erin Welsh	So fish don't just use electricity to shock prey, there are also many species that have electroreception abilities rather than electrogeneration. Can you talk about how these fish sense electricity?

Timothy Jorgensen	The concept of an electrical field is a very difficult one. And the first person to even suggest there were such things was Michael Faraday and when he first proposed this to people that there were electrical fields. He got a tremendous amount of criticism and he backed off. But he was absolutely right that there can be an electrical field between any positive charged electrode and any negative charged electrons. So the way you can think of this and you may have seen this when you were a kid if you had a bar magnet and you spread iron filings on a piece of paper over the bar magnet, you'll see that there's lines that kind of loop out away from the magnet and back to the north and south poles of the magnet and produce this kind of a spider web effect around the magnet. And people have known about this forever and no one could explain it. And the reason for it is is that magnets have a magnetic field around them. So that's what they look like.
	Well electrodes have an electric field which is something similar to that. It's harder to see. You can see it if you put chemicals on a piece of wetted filter paper and some dye chemicals that are charged between two electrodes on a piece of filter paper, you can see the dye start to make the same kind of lines that you would see on a magnet. So that's an electric field. And fish use this. The electric eel's head is positive and its tail is negative. So you have a separation of charge. And so you have an electric field around the fish, just like you do around the magnet. And the fish is able to sense interruptions in that field.
	Many of the fish, particularly in South America, these fish, the electric eels live in these very murky muddy waters where their eyesight, they can't see. In fact most of them are very small eyes because they're almost worthless to them. And so they're using their electric field to find prey and navigate and they can sense this interruption in the electric field. So they're using it in two ways. They have the electric field that's on all the time and then they have this ability to release electricity in huge amounts and shock the prey. So they're getting double duty out of this electric field. And so that's something else that Faraday discovered. He actually got himself an electric eel, he attached it in the pan, and he didn't have any electronic instruments at the time to measure this. He started moving his finger at various spots around the electric eel and felt different strengths to his finger and concluded that electric eels have electric fields just like any other two electrodes would.
Erin Welsh	That is just so fascinating. I feel like we could absolutely keep going down rabbit holes to explore more of the world of electricity. But instead let's take a quick break here. And then when we get back, I want to know all about your research background and your experiences as a science communicator.
TPWKY	(transition theme)
Erin Welsh	Welcome back everyone! Before the break Dr. Jorgensen and I got into some of the background of how electricity works, what we know about some modern electro therapies, and other adventures in the science and history of electricity. But for this next part I want to turn more towards the field of science communication. In addition to being a science writer, you're also a professor at Georgetown University. Can you talk a little bit about your educational journey? How did you become interested in this field?

Timothy Jorgensen	I have most of my career been a researcher in radiation sciences, specifically the sciences that relate to health. And radiation as most people know is used both diagnostically to identify diseases, everyone has been in for a chest X-ray, and they also know it's used therapeutically to treat cancer and it can also cause cancer. And so I was interested in all those aspects of radiation. And so I started out my career, I got a PhD in radiation sciences from the Johns Hopkins School of Public Health. And then I started to specialize in radiation being used in radiation therapy and how to best use it, how to sensitize tumor cells to therapy so it would be more effective, more curative. And so in particular I studied how radiation damages DNA because that's the mechanism by which it kills cells and how cells can resist that by repairing their DNA. So that was my professional journey.
	Later on I got more interested in how radiation causes cancer because it's also through a mechanism of damaging DNA but this type of damage kind of leads to mutations in cells and causes them to transform to be cancer cells. So most of my research career I worked on those two aspects of the problem. As I've aged, I've done less and less research and more and more teaching which seems to be the fate of many professors. So now I'm head of a program in health physics which is a master's degree program at Georgetown that teaches people how to get into the radiation protection profession and those people work in hospitals but they also work at nuclear power plants, they work in the Nuclear Regulatory Commission. So to implement practical measures to help protect people from the bad effects of ionizing radiation while at the same time enhancing its value in terms of therapy and diagnosis and things like that.
	I fell into writing for the public accidentally when Fukushima happened back in 2011. Being a radiation expert, I was asked by television stations to come on and in real time explain what the risks were to the workers and the surrounding population and the long term risks of this catastrophe that happened at Fukushima. Because of that, people when they had a radiation question, they googled it, my name would often come up. And so I was constantly getting phone calls and emails about people that were concerned about the chest X-ray or eating tuna with radioactivity in it or whatever. And I was happy to talk to these people but some of their questions were more complex than could be answered in a five minute telephone conversation. So I was kind of looking for some kind of book or other resource that I could push people to that explained radiation in layman's terms, so something that was not full of jargon and complicated scientific concepts.
	There are plenty of books out there but they either tend to be textbooks or they tend to be books with an agenda. So if you pick up a book that says Nuclear power: The Power to Save the World, you know it's going to be a pro nuclear power book or if you pick up a that says Nuclear Power: The Power to Kill Everyone on Earth then you know it's not. You don't even have to read the book, you know? So what I wanted to do was write a science-based book without an agenda that enabled people to make their own decisions about the risk levels and whether they were acceptable to them. So I tried in the book not to say well radon is dangerous or radon is not. I tried to explain to them what the risk levels were and let them decide whether or not they want to worry about it. And so I did that for all the different radiation issues that I had received questions about.
	In doing that I realized how much a disadvantage, people who want to get scientific information, what a disadvantage there are because if they go to journals, unless they're scientists, they can't understand what's written in the journals. And much of the of the lay press has an agenda. The media tends to see every issue as a black and white situation where they find an expert who will say one thing, an expert will say another thing, and so everything is this little debate. So that's why I wrote the book and that's how I got into it. It was an accident, purely an accident.

Erin Welsh	How do you feel your experiences as a science communicator have influenced either your teaching style or how you approach learning?
Timothy Jorgensen	In terms of my teaching style, I try to do the same thing in teaching. I try to convey technical information but also I try to tell a story. Usually not to embed it within a story but to tell a story that illustrates the point. I try to make the information not just scientific information in itself but show how why should I care about this? So I think that that's affected me in the classroom. Outside the way I like to gather information is is that I read a lot and I read on a variety of topics. I'm currently on a book about concrete and believe it or not it's one of the most fascinating books I've ever read. And then before that I was reading a novel. So I think that again by reading both fiction and nonfiction, I try to find something that I don't know anything about and often you find connections to other things. And so I think it's just the scientific web, as I said earlier, radiation is very much linked to electricity. My latest thing is that I discovered that electricity is very much linked to sound production and so I'm reading a lot of books about sound now. And so that's the way I approach information is from a variety of different, different angles.
Erin Welsh	Something that Erin and I hear frequently, especially lately and I'm sure you do too, is that recent events have shown just how much the world needs science communicators. Do you feel as though graduate students and medical students should be trained in or are being trained well enough in this style of communication?
Timothy Jorgensen	So I'm so glad that you asked this question. I am so glad because I have something that I've been preaching about this. Okay so the answer is no, they are not trained in this and in fact they are trained in a way that is counterproductive to communication. So what I mean by that is we train scientists, young scientists to write scientific papers. Scientific papers are written in jargon, but worse than that they're written in passive voice. Now if you take any English class, anything about communication, they'll always tell you never use passive voice. But yet scientific papers are generally only written in passive voice but it makes for terrible communication, it makes for awful reading. So I want to make a plug for the Alan Alda Center for Science Communication at State University of New York at Stony Brook. This is a center that is specifically devoted to allow scientists to learn the techniques to communicate better with the public. They run seminars and workshops, they'll come to your university and offer workshops where they try to get scientists to talk like normal human beings. And I think that's extremely valuable and we need to do more of that. So yeah.
Erin Welsh	So what advice would you have for someone who wants to learn more about science communication as a career or maybe someone who is in grad school or med school and just wants to become better communicators themselves?
Timothy Jorgensen	Often people talk about your elevator spiel. So imagine you get on an elevator and someone asks, 'So what do you do'? And you have to explain it by the time you get to the 10th floor or whatever. I think that no matter what you do as a as a scientist or anything else for that matter, that you should be able to come up with a story, basically a five minute story and tell it so that somebody who doesn't know anything about that walks away interested and saying, 'That's an interesting thing that that person does. I need to find out more about that.' So I think you have to start by saying why does this interest me? And you identify the points. This interests me because of x, x, x. And then write yourself a story that includes x, x, x when you tell it and other people will become interested too. So I think that people can do that all the time and talk less among scientists and more with the public and try to refine their elevator talk, so to speak. And I think there'll be a lot of rewards on both sides.
Erin Welsh	So I've got one last question for you. And that is what is the next book or project that you would like to work on?

Timothy Jorgensen	Well I would like to work on something, I don't know what but I mentioned sound earlier and I realized in writing the electricity book that I really don't know much about sound and it's extremely interesting. When I consider something that would be good to write a book about, for me it's a three legged stool. It's got to be something that's some type of physical science because that's my background, it has to be a physical science. It has to be health-related because that again is my stick, I'm in a medical school and somehow it has to impact health. And then lastly, it's got to be really good stories because I have to come up with somewhere between 13-17 entertaining stories that have the breath that I can embed the technical information that I want to get out.
	And so I've been reading a bunch of books about sound and listening to podcasts about sound and if it turns out to be a book that's great, but if it doesn't I'm just enjoying learning about sound because it's something that I hadn't really thought much about before. And so who know? Maybe in a couple of years I'll be on your program talking about my sound book. But it is a very, very interesting field.
TPWKY	(transition theme)
Erin Welsh	Dr. Jorgensen, thank you so much for taking the time to chat with me today. I had such a fun time exploring more about the basics of electricity, I feel like I finally have a good grasp on how it works and also chatting more about some fascinating stories in the world of electricity. And if you want to learn more about electricity I highly recommend checking out Dr. Jorgensen's book 'Spark: The Life of Electricity and the Electricity of Life'. And we'll post a link to the book on our website thispodcastwillkillyou.com. Also on our website are the sources for all of our episodes, transcripts, quarantini and placeborita recipes, our bookshop.org affiliate account, links to music by Bloodmobile, links to merch and Patreon, and so much more. Thanks again to Bloodmobile for providing the music for this and all of our episodes. And thank you to you, listeners. And a special thank you to our generous patrons. We appreciate you so much. We have got a brand new episode on a brand new topic coming out next week, so until then keep washing those hands.