TPWKY	This is Exactly Right.
Erin Allmann Updyke	"There is a dread disease which so prepares its victims as it were for death. A dread disease in which the struggle for soul and body is so gradual, quiet, solemn and the result so sure that day by day and grain by grain, the mortal part wastes and withers away so that the spirit grows light. A disease in which death and life are so strangely blended that death takes the glow and hue of life, and life the gaunt and grisly form of death. A disease which medicine never cured, wealth warded off, or poverty could boast exemption from; which sometimes moves in giant strides or sometimes at a tardy, sluggish pace but slow or quick, it is ever sure and certain."
TPWKY	(transition theme)
Erin Welsh	That was incredible.
Erin Allmann Updyke	That was very dramatic.
Erin Welsh	(laughs) Yeah, you did a great job.
Erin Allmann Updyke	Thank you.
Erin Welsh	So what is that from?
Erin Allmann Updyke	That is from Charles Dickens' 1879 novel Nicholas Nickleby in which he described tuberculosis.
Erin Welsh	Is that why we're here this week?
Erin Allmann Updyke	That's why we're here this week!
Erin Welsh	(laughs) Good, I think that set us up nicely.
Erin Allmann Updyke	I think so too. Hi everybody, welcome.
Erin Welsh	Hi, welcome to This Podcast Will Kill You.
Erin Allmann Updyke	Episode-
Erin Welsh	9
Erin Allmann Updyke	9?!
Erin Welsh	Mm-hmm.
Erin Allmann Updyke	Holy cow.
Erin Welsh	I know. I'm Erin Welsh.
Erin Allmann Updyke	And I'm Erin Allmann Updyke.
Erin Welsh	Thanks for joining us.

Erin Allmann Updyke	We're very excited. (laughs) All right!
Erin Welsh	Do we have any business to take care of?
Erin Allmann Updyke	I don't know, do we?
Erin Welsh	Okay, I actually do.
Erin Allmann Updyke	Oh.
Erin Welsh	I have a self correction.
Erin Allmann Updyke	Okay.
Erin Welsh	Two weeks ago or whenever malaria came out-
Erin Allmann Updyke	I think that will be two weeks ago from when you're listening to this. (laughs)
Erin Welsh	I kept using the word 'cinchon' to talk about actually the Cinchona tree which is the tree whose bark contains quinine. So I just, you know, woops. It's gonna happen.
Erin Allmann Updyke	It happens. Pronunciations are hard.
Erin Welsh	It's Cinchona. You know, I just needed to say that. Yeah and I think the other bit of business is I hope everyone is having a great winter break.
Erin Allmann Updyke	Yeah, if you have that.
Erin Welsh	If you have a break.
Erin Allmann Updyke	We do. For now.
Erin Welsh	Fortunately.
Erin Allmann Updyke	So yeah.
Erin Welsh	And have a happy new year!
Erin Allmann Updyke	Oh, it's already new years by now.
Erin Welsh	Yeah!
Erin Allmann Updyke	This is January 2nd.
Erin Welsh	Yeah! Happy New Year!
Erin Allmann Updyke	Oh my god, it's 2018! I wonder what it's like. We don't know now cause it's not there yet, but...

Erin Welsh	Yeah. I mean, maybe everything's magically better.
Erin Allmann Updyke	Oh wouldn't that be wonderful. All right. Well.
Erin Welsh	Cool. Well on that note, let's start drinking.
Erin Allmann Updyke	Let's do it! What are we drinking? Quarantini time!
Erin Welsh	We are drinking Alcohol Consumption.
Erin Allmann Updyke	(laughs)
Erin Welsh	(laughs) So, thus named because tuberculosis was often referred to as consumption particularly in the 1700/1800s.
Erin Allmann Updyke	Oh that's cool, I never knew the time period of it, I just knew like back in the day.
Erin Welsh	Yeah. I mean that's a rough estimate.
Erin Allmann Updyke	Fine, I'll go with it. 1700s. Cheers!
Erin Welsh	Cheers.
Erin Allmann Updyke	Cheers, darling.
Erin Welsh	Should we try to clink?
Erin Allmann Updyke	Yeah, I don't think it's gonna...
Erin Welsh	I don't know if that picked up.
Erin Allmann Updyke	It's not a good clink. They're coffee mugs. Oh by the way an Alcohol Consumption is essentially a hot toddy. And as always we'll post the recipe on all of our social medias, so check it out.
Erin Welsh	It's delicious.
Erin Allmann Updyke	It is really good.
Erin Welsh	It's way better than I was expecting. This is gonna be my winter drink.
Erin Allmann Updyke	Yeah, it's a good winter drink.
TPWKY	(transition theme)
Erin Welsh	So tuberculosis.
Erin Allmann Updyke	Tuberculosis.

Erin Welsh	A big nasty.
Erin Allmann Updyke	It's a bigger nasty than I realized.
Erin Welsh	I'm thrilled to hear all about the biology of it, so.
Erin Allmann Updyke	Can't wait.
Erin Welsh	Take us away.
Erin Allmann Updyke	Let's do it. So tuberculosis is caused by a bacterium. It's not so very different from one that we've seen already. Do you remember which one, so many weeks ago?
Erin Welsh	Leprosy?
Erin Allmann Updyke	Leprosy! So tuberculosis is another bacterium in the same genus, Mycobacterium. This time Mycobacterium tuberculosis, so they name them so that you can remember them easily. It probably evolved from a cattle bacteria, I don't know if you're gonna talk about its evolutionary history later.
Erin Welsh	Very briefly.
Erin Allmann Updyke	All right. So we'll very briefly cover it here too. Probably evolved from cattle bacteria. There's actually still cases of zoonotic tuberculosis that are caused by the bacterium that normally causes bovine TB, they're very similar bacteria. Also similar to leprosy, tuberculosis is transmitted via respiratory droplets. So you cough or whatever and the spittle that you spit out is full of bacteria and when it gets into someone's face or also, and this is what's different than leprosy, TB can hang out in the actual air. Because they're teeny tiny particles, so you can cough, if you have TB and you cough a bunch and then another person walks into the room and breathes, they can get TB.
Erin Welsh	That is a nightmare.
Erin Allmann Updyke	I know!
Erin Welsh	That's horror movie.
Erin Allmann Updyke	It's crazy. But what's really interesting about TB is that if you get infected, you only have about a 5-15% chance of actually developing active TB which is the disease, TB. So TB can get a little bit confusing, so I'm gonna do something a little different today.
Erin Welsh	Okay.
Erin Allmann Updyke	I'm gonna walk you through what happens in your body when you get exposed to tuberculosis.
Erin Welsh	Oh my gosh, I'm so excited.
Erin Allmann Updyke	Oh good, I'm excited that you're excited. (laughs) Okay, so. You're a little Mycobacterium, okay?

Erin Welsh	Hi!
Erin Allmann Updyke	I'm gonna call you Teebs.
Erin Welsh	Oh, oh my gosh!
Erin Allmann Updyke	That's cute, right? So you're just swimming along and then all of a sudden, achoo!
Erin Welsh	Uh oh.
Erin Allmann Updyke	You get sneezed out into the open air.
Erin Welsh	I'm free! Yay!
Erin Allmann Updyke	You're free, luckily. The person that you came from was a close talker, so you end up flying pretty much-
Erin Welsh	Those are the worst!
Erin Allmann Updyke	I know, right? You end up flying pretty much directly into the face of a brand spanking new human.
Erin Welsh	I hope this one is also a close talker because I wanna be exposed to as many people as possible.
Erin Allmann Updyke	Oh you will be. Okay, so now here you are with a few of your friends that you brought with you and you find yourself in the upper respiratory tract of a new human. It's pretty cool, right?
Erin Welsh	Yeah.
Erin Allmann Updyke	You get settled in, you make yourself at home near a bunch of cells that make mucus that are kinda trying to get rid of you. It's not exactly a warm welcome, they're like beating their cilia at you like, 'Who the heck are you!? Get outta here!'
Erin Welsh	Hey man, just let me hang out here, it's no big deal.
Erin Allmann Updyke	Yeah, right? And for most people, or for most bacteria rather, that would be enough. They're like, 'Man, I just can't take this. I'm outta here.' And that's the end of the story.
Erin Welsh	But I'm not most bacteria am I?
Erin Allmann Updyke	No you're not, little Teebs. You're really not.
Erin Welsh	(laughs) Aw.
Erin Allmann Updyke	All right, so you made it past the beaters and the bludgers up in the upper respiratory tract and you're finding your way down to the bottom of the lungs, the alveoli. All right, these are the pockets in your lungs where the gas exchange actually happens.

Erin Welsh	And that's what I want.
Erin Allmann Updyke	That's where you wanna be. So you make it there and then all of a sudden some freaking macrophages-
Erin Welsh	Ugh!
Erin Allmann Updyke	Right? They're basically like Pac-Men. They're giant Pac-Men and they come in and they are literally trying to eat you.
Erin Welsh	Uh uh, I'm not gonna stand for that.
Erin Allmann Updyke	Exactly. So at this point your human host, he knows you're there, right? They probably don't actually but their immune system does. So the immune system is now basically surrounding you. You and your brothers and your friends are just like surrounded by the immune system.
Erin Welsh	Uh oh.
Erin Allmann Updyke	So in a lot of stories this would be the end. The human would kick the infection but-
Erin Welsh	Is this not most stories?
Erin Allmann Updyke	This is not most stories.
Erin Welsh	Yes!
Erin Allmann Updyke	(laughs) You, little Teebs, you keep right on kicking.
Erin Welsh	Ah, man.
Erin Allmann Updyke	You just slowly multiply. Not as slow as your cousin Myc leprae, remember him?
Erin Welsh	Oh yeah, oh Mycie. Man, what a slowpoke.
Erin Allmann Updyke	Real slow. But you're pretty slow too, maybe once every 25-32 hours you might divide.
Erin Welsh	You know that's fast for some people, so.
Erin Allmann Updyke	You're right, Teebs. Sure is. So the immune system just keeps trying to fight you off and you just keep slowly growing. And this goes on and on for like two, maybe twelve weeks, somewhere in that range.
Erin Welsh	Man, we are like at a standoff.
Erin Allmann Updyke	Yes, you really are.
Erin Welsh	But I'm secretly back there just like building my army?
Erin Allmann Updyke	Just building, building.

Erin Welsh	(mischievous snickering)
Erin Allmann Updyke	And eventually you end up pretty trapped in a little ball surrounded by immune cells. The tissue around you might become necrotic, it might die a little bit, the pH might drop and the environment will become really acidic, they'll stop sending food to you, but you just keep living.
Erin Welsh	That's not fair.
Erin Allmann Updyke	It's not fair. But you don't do anything. You're not even growing much anymore, you're just still there.
Erin Welsh	I can just picture myself leaning back, elbows crossed like, 'Go on. Keep coming.'
Erin Allmann Updyke	Exactly.
Erin Welsh	Throw everything you got at me.
Erin Allmann Updyke	And this, my friends, is the latent stage of tuberculosis. So your human isn't infectious at this point but that doesn't mean you're dead. You're just biding your time because eventually your human host, it's gonna get old.
Erin Welsh	Listen, patience is a virtue.
Erin Allmann Updyke	Exactly. They're gonna get old or they're gonna get sick and then those immune cells around you are gonna have to go off and deal with the oldness and the sickness and you, well your time has come.
Erin Welsh	Just when their backs are turned.
Erin Allmann Updyke	(laughs) So you'll break free with your friends and your family and you'll go forth and you'll multiply.
Erin Welsh	Aha!
Erin Allmann Updyke	And that is when you get an active TB infection.
Erin Welsh	Oh, yeah!
Erin Allmann Updyke	(laughs)
Erin Welsh	(laughs)
Erin Allmann Updyke	Was that fun?
Erin Welsh	I loved that!
Erin Allmann Updyke	Good.

Erin Welsh	I could see it perfectly, so much better than Osmosis Jones.
Erin Allmann Updyke	Right?
Erin Welsh	Make that a movie.
Erin Allmann Updyke	Oh my god, I forgot about Osmosis Jones.
Erin Welsh	(laughs) So I remember our 8th grade science teacher got real up in arms about it cause it should really be called 'Diffusion Jones'.
Erin Allmann Updyke	I remember a science teacher saying the same thing.
Erin Welsh	Cause osmosis is only water.
Erin Allmann Updyke	Right, exactly. Oh man that's funny.
Erin Welsh	Anyway that was fantastic.
Erin Allmann Updyke	Oh good, I'm glad. So that is sort of how TB initially happens. So do you wanna talk about the symptoms?
Erin Welsh	Yeah. So what's happening now that I'm inside somebody else?
Erin Allmann Updyke	Great question. So the symptoms associated with active TB are actually pretty nonspecific but they are really long-lasting. So you often end up with progressive fatigue, malaise, general weakness, maybe some weight loss. You'll definitely get a cough, right, because Teebs and all of your friends and family are just filling your lungs with bacteria. You'll probably have fever, night sweats, you probably don't have much of an appetite since your immune response is on high alert so that's why you end up losing a lot of weight. And that cough might be nondescript and unproductive at first but it eventually will end up with what they call purulent sputum.
Erin Welsh	That does not sound good.
Erin Allmann Updyke	Right? And it's often bloody.
Erin Welsh	Ugh.
Erin Allmann Updyke	You've seen the movie, right?
Erin Welsh	The movie?
Erin Allmann Updyke	Moulin Rouge.
Erin Welsh	Oh yes. Yeah.
Erin Allmann Updyke	You've seen that, you've probably seen a hundred other movies where somebody dies of TB and the way that you know they're dying of TB is they're coughing up blood and you're like, 'Well, there you go. They're gonna die.'

Erin Welsh	I just watched Bleak House, the BBC production, and-
Erin Allmann Updyke	(laughs) I don't know what that is.
Erin Welsh	It's a Charles Dickens novel! And not Nicholas Nickleby.
Erin Allmann Updyke	Yeah.
Erin Welsh	Yeah and so one of the characters - spoilers, but the book's been out for over like 140 years - dies of TB.
Erin Allmann Updyke	Yeah so it's not much of a spoiler at that point. Yeah so the infection might be mild for like months. You literally could be coughing up Teebs and friends and family for months without going to the doctor because you're like, 'Oh I've got bronchitis,' or 'I just have a cold' or whatever. So remember when we talked about R0, the number of secondary infections that you get from an single infectious person?
Erin Welsh	Right.
Erin Allmann Updyke	Guess what it is for TB.
Erin Welsh	Ooh. And this is under current circumstances like today's population level?
Erin Allmann Updyke	You know that's a good question. This number's from the World Health Organization so I would guess that it's in current, yeah.
Erin Welsh	Okay.
Erin Allmann Updyke	If a person goes undetected and untreated.
Erin Welsh	Okay so I'm gonna guess the R0, so the number of people that one infectious person can infect with TB, I'm gonna guess 3.
Erin Allmann Updyke	Wow. Keep going.
Erin Welsh	6?
Erin Allmann Updyke	Keep going.
Erin Welsh	9?
Erin Allmann Updyke	Keep going.
Erin Welsh	10!?
Erin Allmann Updyke	10-15 literally. You could infect 10-15 people with TB over the course of a year.
Erin Welsh	My jaw dropped.

Erin Allmann Updyke	I know. And without treatment the mortality rate is 45%. I really did not know that!
Erin Welsh	I have so many questions but I know that they're all going to be answered in the current events, so I'm just gonna have to hold them in.
Erin Allmann Updyke	Yeah, hold them in. Hold them so tight.
Erin Welsh	(laughs)
Erin Allmann Updyke	Yeah.
Erin Welsh	Wow!
Erin Allmann Updyke	I know. Like I knew that back in the day everybody died, it was either syphilis or TB that everyone was dying from but I really didn't know that the mortality rate was that high.
Erin Welsh	It also sounds like a really horrible way to die.
Erin Allmann Updyke	It's also, that's the mortality rate if you're immunocompetent.
Erin Welsh	Ooh.
Erin Allmann Updyke	People with HIV are 20-30 times more likely to develop active TB and it's almost 100% fatal.
Erin Welsh	20-30 times more likely to develop TB.
Erin Allmann Updyke	Exactly. Yeah.
Erin Welsh	And 100% fatal.
Erin Allmann Updyke	And almost every one of them will die.
Erin Welsh	That's really awful.
Erin Allmann Updyke	It's really gnarly. And so while the respiratory system is the most common place that tuberculosis invades and infects because the route of transmission is respiratory, it's not the only place. You can get some weird TB as it turns out. (laughs) They call it extrapulmonary TB.
Erin Welsh	Ooh. This is sounding weird. Keep going.
Erin Allmann Updyke	Right? It's basically just when you have Mycobacterium tuberculosis growing in literally any tissue that's not your lungs, it's considered extrapulmonary. The most serious of these as you might guess, cause it's kind of the most serious place for any creature to invade, is your central nervous system.
Erin Welsh	Aha.
Erin Allmann Updyke	So you can end up with meningitis, they call it tubercular meningitis.

Erin Welsh	Okay.
Erin Allmann Updyke	And we've talked about meningitis before, it's basically just an inflammation of the outer layer that surrounds your brain and spinal cord, your meninges. You can also end up with essentially almost tumors where you have tons of bacteria surrounded by immune cells that just take up space in your nervous system which you can imagine is really problematic.
Erin Welsh	Yeah what happens in that case? Do you become paralyzed in certain areas or lose motor function?
Erin Allmann Updyke	They're called space-occupying tuberculomas.
Erin Welsh	Okay.
Erin Allmann Updyke	Which as far as I know is just a granuloma that takes up space in your central nervous system. So I would guess that you're gonna have some kind of nervous involvement but I didn't really look that much into the symptoms of it.
Erin Welsh	That's okay.
Erin Allmann Updyke	Sorry. Another form of extrapulmonary TB that's almost always fatal is when it invades your bloodstream.
Erin Welsh	Ooh.
Erin Allmann Updyke	Yeah. You can imagine that having any bacteria grow in your bloodstream is pretty much bad news. And this, which is called disseminated TB, is particularly hard to deal with because it progresses really rapidly and it's really difficult to diagnose. So that sucks.
Erin Welsh	Yeah, that sounds terrible.
Erin Allmann Updyke	Yeah.
Erin Welsh	Side note: is disseminated also called miliary?
Erin Allmann Updyke	Yes.
Erin Welsh	Okay.
Erin Allmann Updyke	Yeah, disseminated TB is also called miliary TB.
Erin Welsh	Okay. I kept seeing that pop up in different areas and I was like, yeah. It sounded like the same thing.
Erin Allmann Updyke	Yeah.
Erin Welsh	And you know why they call it miliary?
Erin Allmann Updyke	No, tell me!

Erin Welsh	Cause they look like little millet seeds, so it disperses throughout your body.
Erin Allmann Updyke	That's grody.
Erin Welsh	Yep.
Erin Allmann Updyke	Grody. You also can get invasion of your lymph system which is actually the most common form of extrapulmonary TB. It can infect your bones, your joints, your GI tract, your genital tract-
Erin Welsh	Ooh!
Erin Allmann Updyke	Yeah, genital TB is a thing. You also can get TB in your skin. Like it just can grow everywhere.
Erin Welsh	So you just like throw a dart at a body and you can have TB in any part of that?
Erin Allmann Updyke	100%.
Erin Welsh	Ew. Yikes.
Erin Allmann Updyke	Yeah.
Erin Welsh	But it's primarily pulmonary?
Erin Allmann Updyke	It's is primarily pulmonary.
Erin Welsh	Lungs.
Erin Allmann Updyke	Lungs. Yeah and that's basically what I think you wanna know about the biology of tuberculosis. What do you think?
Erin Welsh	I think that's great. I think you did great, I think tuberculosis is terrible.
Erin Allmann Updyke	It is. Yeah it's more terrible than I even realized.
Erin Welsh	Yeah.
Erin Allmann Updyke	That's true of almost every disease that we've talked about.
Erin Welsh	Yep.
Erin Allmann Updyke	Yeah.
Erin Welsh	Turns out the more you read, the more you're horrified.
Erin Allmann Updyke	The more you know!
Erin Welsh	The more you know, the sadder you'll be. (laughs)

Erin Allmann Updyke	The more you'll wanna stay home and never touch anyone.
Erin Welsh	Yeah not to mention airplanes.
Erin Allmann Updyke	Oh my god.
TPWKY	(transition theme)
Erin Allmann Updyke	So you wanna tell me how this all started?
Erin Welsh	I absolutely do.
Erin Allmann Updyke	Yes!
Erin Welsh	You know that I do.
Erin Allmann Updyke	I know.
Erin Welsh	Okay. Every week I start with where the earliest evidence for infection can be found for whatever disease we're talking about.
Erin Allmann Updyke	Can I guess?
Erin Welsh	I was gonna say, yeah. Please guess.
Erin Allmann Updyke	(laughs) Is it Egypt?
Erin Welsh	You got it! Ding ding ding ding ding!
Erin Allmann Updyke	Winner winner!
Erin Welsh	Yep, Egyptian mummies as per usual. Tuberculosis leaves traces of infection of bone kind of like its cousin disease, leprosy.
Erin Allmann Updyke	Aha.
Erin Welsh	So researchers can actually do postmortem diagnosis on skeletons that are thousands of years old which is really cool.
Erin Allmann Updyke	Oh my god. That is amazing.
Erin Welsh	Okay. So we've got skeletal evidence of tuberculosis in Egyptian mummies dating from around 3700 BC. We've also got skeletal evidence of TB dating back a few thousand years in other Old World regions such as India and China.
Erin Allmann Updyke	Wow.
Erin Welsh	But another thing we have, and this is really exciting, we have skeletal evidence of tuberculosis in a mummy from Peru dating back to almost 3000 years ago.

Erin Allmann Updyke	No!
Erin Welsh	That means that tuberculosis was in the Americas long before the European invasion.
Erin Allmann Updyke	What?
Erin Welsh	Yeah! Isn't that insane?
Erin Allmann Updyke	Wait that's really cool! That's really interesting!
Erin Welsh	Yeah! It's incredible. So from what I read, it could have either been brought over during the early migrations to North and South America or it could've evolved to infect humans from the cattle-borne version of tuberculosis like you mentioned which was present in ungulates during that time like alpaca or llamas or bison.
Erin Allmann Updyke	So would that mean that there was more than one evolution of tuberculosis?
Erin Welsh	I don't know if that's the case. So the thing is I don't know the different clinical manifestations of the cattle-borne version of the disease and what was on the skeletal remains.
Erin Allmann Updyke	Okay. But you maybe can't tell in a mummy if it was maybe from a bovine TB vs actual Mycobacterium tuberculosis.
Erin Welsh	Exactly.
Erin Allmann Updyke	Interesting.
Erin Welsh	So I don't know.
Erin Allmann Updyke	Oh that's so cool though.
Erin Welsh	Yeah. Very cool.
Erin Allmann Updyke	Wow.
Erin Welsh	Ancient Greek physicians described the pulmonary form of tuberculosis and called it phthisis, which is spelled horribly. All right, you ready?
Erin Allmann Updyke	I'm ready.
Erin Welsh	P-H-T-H-I-S-I-S. Yeah, that's a 'ph' and a 'th' at the beginning. I had to look it up, I'm pretty sure it's 'tye-sis'.
Erin Allmann Updyke	You always look up how to pronounce things and I don't so probably people are like, 'Oh god Erin with the pronunciation!'
Erin Welsh	(laughs) Also it just seemed too ridiculous to have to pronounce it 'puh-thy-sis'.

Erin Allmann Updyke	(laughs)
Erin Welsh	Fuh-thy-sis'. (laughs) Well and anyway, phthisis means wasting away which is kind of the precursor of consumption.
Erin Allmann Updyke	Yep.
Erin Welsh	Tuberculosis in Ancient Greece was devastating enough to be written about for hundreds of years and writers often noted that children were particularly affected by the disease.
Erin Allmann Updyke	Ugh, yeah.
Erin Welsh	Yep. And their method for treating TB? Bloodletting of course.
Erin Allmann Updyke	Of course.
Erin Welsh	Ancient Greek physicians believed that disease was caused by an imbalance in one of the four humors of the body, one of them being blood. So when someone started coughing up a bunch of blood and showing their doctor, the doctor was like, 'Ugh, you know, you've got too much blood in your body! I can help you.'
Erin Allmann Updyke	Way too much, gotta get rid of it. (laughs) Let's get that bad boy out.
Erin Welsh	Come over here, give me your arm! No big deal.'
Erin Allmann Updyke	Oh dear.
Erin Welsh	Obviously this did nothing to help the patient and probably made them sicker but I guess you can't really fault them for trying something? I dunno. For the next, oh, 1600 years or so, basically until the industrial revolution, tuberculosis continued at a slow burn throughout much of the world with no crazy pandemic that wiped out the majority of the population like the plague did.
Erin Allmann Updyke	Okay.
Erin Welsh	But that doesn't mean that it wasn't super impactful or that it wasn't noticed enough to be written about because it was. And around 1000 AD the reign of the crazy Greek physicians had long since ended and a new cure came on the scene. And this one may have actually done some good? The poor and the sick flocked by the thousands to the castles of European royalty where the king or queen would perform, quote: "the royal touch".
Erin Allmann Updyke	Oh. Ooh.
Erin Welsh	Sounds creepy.
Erin Allmann Updyke	It sounds really creepy.

Erin Welsh	Yeah. (laughs) An afflicted individual would kneel at the feet of a monarch, the monarch would then place their hands on the sores or affected areas of the patient while a priest said a prayer. Sometimes the patient would be allowed to stay for a few days or weeks in the castle area. And for many of them the royal's touch actually did some good but not because the monarch had any kind of magical healing power, it's more likely that rest and an improved diet helped to bolster their immune system.
Erin Allmann Updyke	They're like eating off of the king's table instead of just not eating.
Erin Welsh	Oh, vegetables!
Erin Allmann Updyke	Right.
Erin Welsh	This is amazing. And once they were back home working in the fields and eating what little they could afford, the TB probably came back with a vengeance.
Erin Allmann Updyke	Yep.
Erin Welsh	Nevertheless the practice remained pretty popular. The last royal touch in Europe was done in 1886.
Erin Allmann Updyke	Wow! Dickens was around!
Erin Welsh	(laughs) Yeah! Yeah he was. Good old Dickens.
Erin Allmann Updyke	(laughs) Wow.
Erin Welsh	It's important to note that the contagious nature of tuberculosis was still unknown throughout all of this royal touching.
Erin Allmann Updyke	I was gonna ask like they were just exposing themselves like crazy, that doesn't seem like a royal thing to do.
Erin Welsh	I mean if they knew that it was contagious do you think that any monarch would be like, 'Oh yes, come here. Let me touch you.'
Erin Allmann Updyke	There's literally no way.
Erin Welsh	No. Not at all. By the early 1700s tuberculosis was fairly common and extremely widespread although it wasn't exclusively a disease of poverty, it did disproportionately affect those who were forced to live butt to elbows in cramped, dingy houses with poor ventilation.
Erin Allmann Updyke	(laughs) Butt to elbows.
Erin Welsh	(laughs) And the number of people living in these conditions took a huge upsurge following the industrial revolution. Before the industrial revolution which happened around the mid 1700s to the mid 1800s, the norm was small-scale farming and manufacturing with much of the population living in dispersed villages. Under these conditions, tuberculosis can still exist but it's not going to thrive the way it would during the Industrial Revolution. Basically what happened during this time was a shift away from these individual, hand-production methods to large-scale mechanized production of things like textiles, steel equipment, tools, etc.

Erin Allmann Updyke	Right.
Erin Welsh	Cities became centers for productions and people flocked there en masse. Soon thousands or millions of people were living in these new metropolitan areas. To give you some idea of just how massive this influx was , between 1800 and 1850, in just 50 years, New York grew in population from 60,000 to over 500,000.
Erin Allmann Updyke	What? In 50 years? That's insane.
Erin Welsh	Massive. Almost tenfold.
Erin Allmann Updyke	Yeah!
Erin Welsh	Yeah.
Erin Allmann Updyke	Wow. Yeah so everyone was just like coming to cities which were also filthy and dirty as we've talked about before.
Erin Welsh	And made more filthy and dirty by all these people coming.
Erin Allmann Updyke	By tons of people coming. And then they're just breathing on each other.
Erin Welsh	Positive feedback loop.
Erin Allmann Updyke	(laughs) Yeah.
Erin Welsh	And there was no way that housing or building construction could keep pace with this kind of population growth, so many people were forced to live in extraordinarily crowded conditions.
Erin Allmann Updyke	Ugh.
Erin Welsh	Houses meant to hold a single family were instead occupied by seven families.
Erin Allmann Updyke	Oh man.
Erin Welsh	In many boarding houses, people rented beds in shifts and when your shift ended you had to give up your bed to someone else. This way the bed never got cold.
Erin Allmann Updyke	Oh my god. Oh! Can you just... Ugh, sleeping in someone else's filth! Can you just imagine that?
Erin Welsh	(laughs) I mean I've been through some pretty sketchy hostel situations.
Erin Allmann Updyke	Yeah me too but I still feel like there's like, I don't know.
Erin Welsh	I mean you're also, you're not just sleeping in someone else's filth, you're sharing bed bugs, lice...
Erin Allmann Updyke	Yeah, you're sharing everything.

Erin Welsh	Fleas. Yeah.
Erin Allmann Updyke	Ugh.
Erin Welsh	We can't stress enough how disgusting this was.
Erin Allmann Updyke	We are disgusted.
Erin Welsh	(laughs) And although jobs were plentiful, working conditions were even more hazardous than living conditions. Wages could barely get you clothed and fed.
Erin Allmann Updyke	Ugh.
Erin Welsh	It's no wonder really that under these crowded, malnutritious, and poor conditions tuberculosis flourished.
Erin Allmann Updyke	It was probably really happy. Teebs was just like (purring sound). 'This is my dream world!'
Erin Welsh	Oh yeah. I mean flourished doesn't really even begin to describe the uptick in cases during the Industrial Revolution.
Erin Allmann Updyke	Yeah.
Erin Welsh	It's estimated-
Erin Allmann Updyke	Oh.
Erin Welsh	Yeah, here's some numbers.
Erin Allmann Updyke	Gimme gimme.
Erin Welsh	That by 1850, between 75-90% of all people on earth had the tuberculosis bacterium in them.
Erin Allmann Updyke	What!?
Erin Welsh	And 20% of those would go on to develop the disease.
Erin Allmann Updyke	Holy whoa. So you have 90% of people that have the bacterium and 20% of them end up getting... I mean that's higher than we see today probably because of how horrible everyone's immune status was.
Erin Welsh	I mean cause you weren't just infected with TB, you probably were gonna be exposed to cholera, to smallpox at some point.
Erin Allmann Updyke	Everything. All the things we've talked about. Malaria.
Erin Welsh	Syphilis. I mean the list goes on and on and on.

Erin Allmann Updyke	It really does.
Erin Welsh	So yeah, tuberculosis really had a grip on the world.
Erin Allmann Updyke	Wow.
Erin Welsh	At one hospital in Paris, because you know how I love stats-
Erin Allmann Updyke	I do, yeah.
Erin Welsh	At one hospital in Paris in the early 1800s, tuberculosis was identified to be the cause of death in more than 1/3 of all autopsies.
Erin Allmann Updyke	Whoa.
Erin Welsh	At least a contributing factor if not the cause of death in the majority I think of all autopsies, probably.
Erin Allmann Updyke	Dang, dude.
Erin Welsh	Mm-hmm. And it was during this period of high tuberculosis spread that tuberculosis got its reputation as a disease of creative types, of those with low morals who indulged in too much drink and too much sex.
Erin Allmann Updyke	I don't think I knew that about tuberculosis. (laughs)
Erin Welsh	I mean, think of Moulin Rouge.
Erin Allmann Updyke	Oh that's true, yeah. That's definitely true.
Erin Welsh	Tuberculosis or consumption as it was known during this time due to the way that a person wasted away while infected was almost fashionable.
Erin Allmann Updyke	Like if you had TB you must be in with the 'in' crowd?
Erin Welsh	Well kind of. It was the look. So appearing pale and gaunt became in style and women began starving themselves, drinking only lemon water or in one case eating sand to achieve the chic consumptive look.
Erin Allmann Updyke	I'm sorry, was it Gwyneth Paltrow? (laughs)
Erin Welsh	Next on GOOP.
Erin Allmann Updyke	The consumption look: how to get yours.
Erin Welsh	(laughs) Here's a bag of sand for only $89.95, four small installments.
Erin Allmann Updyke	(laughs) Oh my god, that's awful.

Erin Welsh	Mm-hmm.
Erin Allmann Updyke	I hate that idea.
Erin Welsh	Yeah. It's really bizarre. And reading a list of famous victims of tuberculosis during the 1800s reads like a who's who of the art, music, literary world. We've got the Bronte sisters who wrote Jane Eyre and Wuthering Heights. We've got Edgar Allen Poe, the Raven, Tell-Tale Heart, etc.
Erin Allmann Updyke	Of course.
Erin Welsh	Robert Louis Stevenson, Treasure Island.
Erin Allmann Updyke	Oh.
Erin Welsh	Henry David Thoreau, Walden, like Walden Pond.
Erin Allmann Updyke	The pond.
Erin Welsh	Franz Kafka, Metamorphosis.
Erin Allmann Updyke	I remember that.
Erin Welsh	It's one of my favorites.
Erin Allmann Updyke	Yeah.
Erin Welsh	George Orwell.
Erin Allmann Updyke	1984!
Erin Welsh	Animal Farm, mm-hmm.
Erin Allmann Updyke	Wow.
Erin Welsh	And that's not including the composers Chopin, Paganini, I mean the list goes on and on and on. That was just a small sampling, like a tiny, teeny tiny sampling of all the celebs who died of tuberculosis. Eleanor Roosevelt - tuberculosis.
Erin Allmann Updyke	Really?
Erin Welsh	Mm-hmm. Why was this disease so, in a way, celebrated when other slow-burning diseases like leprosy or syphilis elicited feelings of terror and disgust?
Erin Allmann Updyke	Well leprosy probably was gnarlier to look at.
Erin Welsh	Well that's the thing. So at this point people didn't know that it was contagious.
Erin Allmann Updyke	Oh.

Erin Welsh	And except for looking pale and emaciated which was en vogue, there were no other superficial signs of tuberculosis. Most commonly not many open sores, no nervous system involvement for the typical cases.
Erin Allmann Updyke	Right. Yeah, exactly.
Erin Welsh	And so it was viewed as almost a romantic disease, a great plot device.
Erin Allmann Updyke	Wow.
Erin Welsh	I mean we already know from the intro that Dickens loved tuberculosis.
Erin Allmann Updyke	Yeah. Wow that's so interesting.
Erin Welsh	Yeah.
Erin Allmann Updyke	God, I've said interesting like a hundred times already.
Erin Welsh	I mean, it is interesting though.
Erin Allmann Updyke	You need to look up some synonyms in the future.
Erin Welsh	(laughs) So we know now of course that tuberculosis is transmitted through respiratory droplets but when and how was this discovered?
Erin Allmann Updyke	Yeah! Good question!
Erin Welsh	Well to answer that I'm gonna tell you a little story.
Erin Allmann Updyke	Yes.
Erin Welsh	A story of a bitter rivalry, of scientific revolution, and of hopes raised so high only to be dashed to the ground, resulting in ruined reputation and heartbreaking despair.
Erin Allmann Updyke	Okay I am like really into this right now.
Erin Welsh	(laughs) I hope it lives up to it.
Erin Allmann Updyke	(laughs)
Erin Welsh	The star of the story is none other than Robert Koch.
Erin Allmann Updyke	Ah.
Erin Welsh	If you've ever taken a microbiology course, AKA the study of microorganisms like bacteria, viruses, fungi, etc. you've heard the name Koch.
Erin Allmann Updyke	Mm-hmm.

Erin Welsh	Probably in reference to Koch's postulates - we'll get to that. First though, let's meet the man himself.
Erin Allmann Updyke	Yes!
Erin Welsh	Robert Koch was born in Germany in 1843 and as a young man during the Franco-Prussian War, which was between France and Germany, Koch worked in field hospitals performing hundreds of misguided amputations and generally witnessing the horror of war firsthand.
Erin Allmann Updyke	Wow.
Erin Welsh	This experience would stay with him for the rest of his life and provided some of the basis for his belief in germ theory and his resentment toward the leading microbiologist of the day, the Frenchman Louis Pasteur. Cause it was Germany vs. France.
Erin Allmann Updyke	(gasps) Oh that's fun.
Erin Welsh	I was like, 'Oh my gosh, there's a political side to this!'
Erin Allmann Updyke	Koch and Pasteur were rivals? I didn't know that.
Erin Welsh	Huge. There is some like pure venom in public letters to each other.
Erin Allmann Updyke	Ooh. (sings) Now we got bad blood, you know we used to be-
Erin Welsh	100%!
Erin Allmann Updyke	(laughs)
Erin Welsh	Except they never used to be mad love.
Erin Allmann Updyke	Right, they just were only bad blood.
Erin Welsh	Only. (laughs) Oh my god. Yeah okay. After getting burnt out on the fields of war, Koch returned home to a small village in western Germany where he acted as the town doctor. On his birthday - I dunno, some time in his 30s, I saw conflicting things - his wife gave him a gift that would change the course of medicine and history.
Erin Allmann Updyke	Way to go, wife.
Erin Welsh	A microscope.
Erin Allmann Updyke	(screams)
Erin Welsh	Yeah! Immediately he was enamored with it and used it to examine everything he could think of. At this time, which was in the 1870s, germ theory was making major splashed but still remained a controversial topic. And as a reminder, germ theory is the idea that certain diseases are caused by microscopic organisms such as bacteria or viruses.
Erin Allmann Updyke	It's like not a very shocking theory today in 2017. (laughs)

Erin Welsh	No but at the time it was revolutionary.
Erin Allmann Updyke	Exactly, yeah. It's so hard to imagine living in a time like that.
Erin Welsh	I mean we are though. You know that there's bound to be something 50, 100, 200 years from now that they're gonna look back and go, 'Wow, how did you not know!?'
Erin Allmann Updyke	How did you not know. Man I never thought about that. Wow.
Erin Welsh	(laughs) We even look at medical practices of the 70s and 80s and go, 'Come on!'
Erin Allmann Updyke	That's very true, what were you thinking. I bet it's gonna be antibiotics, that's gonna be the thing.
Erin Welsh	Antibiotics. I heard chemotherapy is one where they're gonna look back and go, 'That's torture.'
Erin Allmann Updyke	It kind of is, man.
Erin Welsh	Yeah it is. Yeah. So anyway Koch, aware of germ theory but not completely convinced, decided to examine the blood of some sheep who had recently died in an anthrax epidemic in his town.
Erin Allmann Updyke	Whoa!
Erin Welsh	To his surprise, he saw millions of rod-shaped bacteria under the microscope.
Erin Allmann Updyke	Oh that's cool.
Erin Welsh	Not wanting to jump the gun, which was unlike pretty much every other scientist during this time, he set about designing a series of experiments which would conclusively show that anthrax was caused by this bacilli that he saw.
Erin Allmann Updyke	Oh that's awesome.
Erin Welsh	First he would isolate the bacterium from a sick animal. Then he would reproduce the bacteria in culture. Then he would inoculate a healthy animal with some of this bacteria-ridden culture. Finally he would isolate the bacterium once again from this newly sick animal. And these, dear listeners, are what is known as Koch's postulates.
Erin Allmann Updyke	You just took Biology 101. (laughs)
Erin Welsh	Yep, I mean essentially.
Erin Allmann Updyke	No really.
Erin Welsh	Isolate, reproduce, inoculate, and isolate again.
Erin Allmann Updyke	Yeah.

Erin Welsh	Easy four steps. And these became standard practice for determining the infectious agent responsible for a particular disease. Because he was able to successfully do this with the anthrax bacilli, this set him apart and made his evidence for germ theory much more convincing. Louis Pasteur, a huge name in microbiology, was more than a bit salty that it was a German man who would take credit for this discovery and that his evidence would be accepted so readily when Pasteur had fought so hard in previous years.
Erin Allmann Updyke	Yeah. He was so messy though. Like Pasteur was just all over the place, you know?
Erin Welsh	Yeah, yeah. This was like the development of actual scientific methods, to a degree.
Erin Allmann Updyke	Right, exactly. Yeah.
Erin Welsh	And so Pasteur decided that he was gonna develop the anthrax vaccine.
Erin Allmann Updyke	(laughs)
Erin Welsh	(laughs)
Erin Allmann Updyke	How'd that go, Pasteur?
Erin Welsh	Oh, it worked.
Erin Allmann Updyke	Oh cool.
Erin Welsh	He did it and it was great. But Koch was like, 'This is this Frenchman cam in here and he took my research and he didn't even credit me.' He was so upset about it.
Erin Allmann Updyke	Oh.
Erin Welsh	I mean these letters are hilarious to read.
Erin Allmann Updyke	Did they write to each other or did they write to like their newspapers about how angry they were at the other one?
Erin Welsh	Yeah it was, if I'm using this word correctly, subtweeting.
Erin Allmann Updyke	(laughs)
Erin Welsh	They were just like, 'Well this guy-' I'm not sure, I don't do Twitter. (laughs)
Erin Allmann Updyke	I'm sorry that was really good. Yeah. Guess which one of us manages the Twitter account? (laughs)
Erin Welsh	(laughs) So I didn't use it right?
Erin Allmann Updyke	No, it's perfect.
Erin Welsh	Okay.

Erin Allmann Updyke	It's perfect.
Erin Welsh	Blissful innocence. Or blissful ignorance.
Erin Allmann Updyke	Yes. Perfect.
Erin Welsh	Yeah. So nationalistic pride ran pretty deep in these two and their feud was famous in its day because it was not only very vicious but, as I mentioned, very public.
Erin Allmann Updyke	But very productive, so at least there's that.
Erin Welsh	Yeah. For the most part. But we're not here to talk about anthrax this week.
Erin Allmann Updyke	No. Future episode.
Erin Welsh	Future. We're here to talk about tuberculosis. Contemporary theories as to the cause of tuberculosis ran from having a weak heart to too much horse riding in youth to a genetic predisposition or maybe playing instruments too much.
Erin Allmann Updyke	Wow.
Erin Welsh	But Koch had a different idea as to its origin. After the anthrax success, Koch set his sights upon tuberculosis. And with tuberculosis he took the same tack as he did with anthrax: isolate, reproduce, inoculate, isolate again. And he was successful.
Erin Allmann Updyke	Wow.
Erin Welsh	Which was huge because it required him to develop staining methods which were really difficult at the time.
Erin Allmann Updyke	Yeah I was gonna say, I actually didn't expect him to be successful so easily because tuberculosis is notoriously difficult to culture, it takes forever to grow.
Erin Welsh	He had to be patient.
Erin Allmann Updyke	What a baller.
Erin Welsh	Uh huh. And then his, also this is a side note, but his student or assistant was named Paul Ehrlich, like Ehrlichia.
Erin Allmann Updyke	Ehrlich, yeah. He's very famous.
Erin Welsh	Yeah and also a great microbiologist in his own right.
Erin Allmann Updyke	Yeah.
Erin Welsh	Actually Ehrlich, who developed the staining method or improved upon the staining method for the acid-fast bacteria like Mycobacterium.

Erin Allmann Updyke	Mycobacterium, yeah.
Erin Welsh	Diagnosed himself with tuberculosis using this technique.
Erin Allmann Updyke	(gasps) Oh my gosh, that's so sad and poetic.
Erin Welsh	Yeah, romantic. There you go.
Erin Allmann Updyke	Oh yeah. (laughs)
Erin Welsh	Hollywood, get on it.
Erin Allmann Updyke	Yeah let's make a movie about Koch and Ehrlich. I'd watch it. I'd watch it for his wife who was like, 'I'm gonna give you the tool that you need to be so famous'.
Erin Welsh	Well sidebar, he left her for a 17-year-old art student when he was in his late 40s, early 50s I think. Yeah.
Erin Allmann Updyke	No longer on the Koch train. No longer on that train. No into it.
Erin Welsh	Oh you would've jumped off before that happened.
Erin Allmann Updyke	Ugh!
Erin Welsh	Okay. So yeah, as I mentioned he was successful in isolating the tuberculosis bacterium but he still wasn't satisfied so he repeated this experiment over and over again until he was sure. In a public presentation on an October day in 1882, Koch announced his findings to the most notable doctors and researchers of the day who were knocked speechless.
Erin Allmann Updyke	Wow.
Erin Welsh	It was really one of the most momentous occasions for science ever, apparently.
Erin Allmann Updyke	That's pretty cool.
Erin Welsh	According to contemporary accounts. I do want to note that Koch was not the first to suggest or even experimentally indicate that tuberculosis was infectious but his experimental evidence backed up with microscopic demonstrations would make his voice the one that was heard. The guy who actually did it was French and so Pasteur was so annoyed.
Erin Allmann Updyke	(laughs)
Erin Welsh	Just kept building in speed.
Erin Allmann Updyke	Poor Pasteur.

Erin Welsh	Oh I know. Unlike the ready acceptance of the anthrax bacilli, the announcement of tuberculosis as infectious was met with resistance initially. Eventually though it gained traction and scientists, including Pasteur, set their sights on a cure. It was a race to the finish line. Who would develop the first tuberculosis vaccine? Koch, determined that he would be the victor, threw himself into his work and emerged less than two years after his first announcement of tuberculosis bearing another supposedly groundbreaking discovery.
Erin Allmann Updyke	Oh.
Erin Welsh	He had concocted a cure for tuberculosis. This supposed cure when injected was supposed to reverse the damaged areas of the lungs and leave the sufferer disease-free. He called the substance tuberculin. Almost immediately tuberculin was one of the most in-demand substances in the world and people rejoiced for the long-awaited tuberculosis treatment that would relieve so many of their suffering. Supply was nowhere near enough to keep up with the demand obviously, which was probably for the best.
Erin Allmann Updyke	Cause I'm guessing it didn't work.
Erin Welsh	Did not work. Sure it produced an immune reaction in the person who has been injected, but it does nothing to heal the patient. Instead it causes fever, pain, and often death.
Erin Allmann Updyke	Oh my god!
Erin Welsh	Particularly in those that were most severely afflicted with tuberculosis.
Erin Allmann Updyke	Ugh.
Erin Welsh	Koch, so intent on beating Pasteur to the finish line, wasn't thorough in his testing of tuberculin and prematurely announced success.
Erin Allmann Updyke	Toxic masculinity, bro. Gets ya every time.
Erin Welsh	There you go. It's ego. Come on.
Erin Allmann Updyke	Yeah.
Erin Welsh	And it would nearly ruin his reputation as a scientist and he was all but chased out of Germany at least immediately after.
Erin Allmann Updyke	Wow! That escalated.
Erin Welsh	So tuberculin, you may have heard that word because it's what people use in TB skin tests for today.
Erin Allmann Updyke	Yeah, yeah.
Erin Welsh	That's where it came from.
Erin Allmann Updyke	That's really cool, I didn't know that's where that came from. That is so interesting.

Erin Welsh	Yeah, yeah. So there the world stood at the end of the 19th century with the knowledge that tuberculosis was infectious but no cure to treat the ill. Tuberculosis was no longer the romantic disease of poets and artists, it was something that would get you reported by your neighbor to the health authority for a nice cash reward.
Erin Allmann Updyke	Whoa.
Erin Welsh	Yeah. Predictably, tuberculosis patients began to be ostracized, their clothing burned, and forced into treatment centers called sanitoria.
Erin Allmann Updyke	Oh, yes! Not yes, but...
Erin Welsh	(laughs) You're excited to learn about sanitoria.
Erin Allmann Updyke	I love this.
Erin Welsh	At the time fresh mountain air combined with a healthy diet and ample lung rest, i.e. no exercise, talking, laughing, singing, etc. was thought to be a cure for tuberculosis. All over the world, these sanitoria started popping up. Not many kept stats on how many people actually recovered and in reality your chances weren't much better in a sanitorium than in your dingy home-
Erin Allmann Updyke	Yeah.
Erin Welsh	But at least in a sanitorium you had someone feeding you and you were resting which probably provided an immune boost. Tuberculosis patients flocked to these places, most of which were A) racially segregated, and B) reserved spots for paying customers only. There were exceptions. For many tuberculosis sufferers, this was the only choice and this would remain the only choice well into the 20th century. For the next 50 years after Koch's failed tuberculin experiment, there would be many attempts to come up with a cure for tuberculosis. But none were successful until a lowly grad student named Albert Schatz studying soil microbes isolated one that when exposed to some bacteria, killed them.
Erin Allmann Updyke	Awesome.
Erin Welsh	So he tested it on a bunch of different types of bacteria, killed 'em all. So Schatz was pretty excited about this and he begged his reluctant advisor to let him test it on tuberculosis. He got permission.
Erin Allmann Updyke	Awesome!
Erin Welsh	And it worked. Finally there was a very promising cure for tuberculosis and it was called streptomycin.
Erin Allmann Updyke	Ah!
Erin Welsh	Over the next few years and after many animal and human trials, streptomycin was ready for distribution. The effects were astonishing. Here finally was the cure humanity had been waiting on for hundreds, thousands of years. Almost overnight tuberculosis sanitoria emptied and many sit abandoned to this day.

Erin Allmann Updyke	Yeah.
Erin Welsh	There's one in Louisville, Kentucky called Waverly Sanitorium. It's huge!
Erin Allmann Updyke	Have you been in it?
Erin Welsh	I haven't, but it's been turned into a haunted house.
Erin Allmann Updyke	Oh yes! This is why... Oh, I love this. Cause they're always really creepy places. They're always the kind of places where people are like, 'Oh that building is definitely haunted. Like no question.'
Erin Welsh	Yeah there are like body chutes and stuff like that.
Erin Allmann Updyke	Yes, they're so creepy!
Erin Welsh	We should do a field trip.
Erin Allmann Updyke	Oh my god.
Erin Welsh	We'll google.
Erin Allmann Updyke	We need to get a digital recorder so that we can record our whole trip.
Erin Welsh	Yeah. (laughs) And so for his amazing discovery which completely changed the world in terms of tuberculosis, Schatz' advisor would receive the Nobel Prize.
Erin Allmann Updyke	0% surprised about that.
Erin Welsh	(laughs) Just a real bummer.
Erin Allmann Updyke	That is typical.
Erin Welsh	Selman Waksman. He got the Nobel Prize.
Erin Allmann Updyke	Schatz, we're looking at you. We know.
Erin Welsh	Thanks buddy.
Erin Allmann Updyke	We're giving you credit.
Erin Welsh	Thanks Al.
Erin Allmann Updyke	Not that it comes with much, but. (laughs)

Erin Welsh	For many years streptomycin seemed like it would bring about the end of tuberculosis. And it came kind of close in some ways, particularly when used in combination with other antibiotics. But TB would return again with a vengeance during the AIDS epidemic of the 1980s and this time antibiotics were no match for resistant strains. I'm gonna let you pick up here. Tell me about tuberculosis in the world today.
Erin Allmann Updyke	Oh okay.
TPWKY	(transition theme)
Erin Allmann Updyke	I wish, actually, that I had a happier way to end this episode but I don't. (laughs)
Erin Welsh	I mean...
Erin Allmann Updyke	So tuberculosis, this actually blew my mind. Tuberculosis is the ninth leading cause of death worldwide.
Erin Welsh	Nine?
Erin Allmann Updyke	Number nine. Isn't that... I mean, seriously? Tuberculosis. This is a bacteria that we can treat and it is to this day the ninth leading cause of death worldwide.
Erin Welsh	That is astonishing.
Erin Allmann Updyke	I know. And for the period from 2012 to 2016 it was the number one cause of death from a single infectious agent.
Erin Welsh	(gasps)
Erin Allmann Updyke	So because most of the other causes of death are either not infectious or they're kind of generalized, like lower respiratory infections which is like pneumonia, it could be caused by a number of different things, TB was the leading cause of death by a single agent. What the F?
Erin Welsh	Whoa.
Erin Allmann Updyke	Yeah!
Erin Welsh	What does that put the mean annual mortality rate at?
Erin Allmann Updyke	Let's talk about it. So in 2016 the incidence, so the number of cases that were reported of tuberculosis, was 10.4 million.
Erin Welsh	What?
Erin Allmann Updyke	10.4 million people in the world were diagnosed with tuberculosis in the year 2016 and the mortality was 1.7 million.
Erin Welsh	(gasps)

Erin Allmann Updyke	Literally 1.7 million people died in 2016 because of tuberculosis. 1.3 million of those were HIV-negative, so generally these are immunocompetent people.
Erin Welsh	Okay.
Erin Allmann Updyke	About 374,000 of them were HIV-positive.
Erin Welsh	Tuberculosis is a leading cause of death in HIV patients.
Erin Allmann Updyke	Yeah it's 40%. There's just so many numbers but 40% of all deaths due to HIV are actually due to TB.
Erin Welsh	Oh my god.
Erin Allmann Updyke	So on the death certificate it will say HIV but 40% of those are because of TB. And we'll talk... So two weeks from now will be HIV and we'll talk so much more about it then but no one really dies from HIV itself, HIV is not what kills you, HIV kills your immune system and then opportunistic bacteria and other things, but opportunistic bacteria like Teebs-
Erin Welsh	Tuberculosis.
Erin Allmann Updyke	-just jump right in there and they sit there and just wait for you to get sick. So yeah. Do you wanna get even sadder?
Erin Welsh	I mean...
Erin Allmann Updyke	If 1.7 million people dying last year isn't enough, a million of the new cases that were diagnosed were children.
Erin Welsh	(gasps)
Erin Allmann Updyke	And 250,000 of those deaths were children.
Erin Welsh	Okay that is horrifying. Is this related to drug resistance at all or just not getting the treatment to the people that need it?
Erin Allmann Updyke	So it definitely has to do with drug resistance. So the World Health Organization estimates that of the cases that are reported to them, treatment is effective if it's not resistant in about 85% of cases.
Erin Welsh	Okay.
Erin Allmann Updyke	So about 85% of people without the resistant form will recover completely. And others might sort of go back to the latent state and not die from it but not be rid of it either. Drug-resistant TB definitely has a major effect. So in 2016 about 600,000 of those cases were resistant to at least one drug.
Erin Welsh	Whoa.
Erin Allmann Updyke	And about 500,000 were resistant to multiple drugs.

Erin Welsh	And so the evolution of drug resistance, I didn't really talk about it very much and I don't know if you're gonna cover it?
Erin Allmann Updyke	I'd love to, you wanna talk about it right now?
Erin Welsh	Yeah, please.
Erin Allmann Updyke	So basically the reason that tuberculosis is so susceptible to becoming resistant is in large part because of how dang long it takes to be treated in order to cure it. So if you have a non-resistant form, a normal TB that's susceptible to antibiotics, it still takes six months of treatment.
Erin Welsh	Wow!
Erin Allmann Updyke	If you have a form that's resistant to only one or two drugs, they now recommend 9-12 months of treatment. They used to recommend 20 months of treatment.
Erin Welsh	Wow.
Erin Allmann Updyke	Yeah. So let's talk really quickly about how antibiotic resistance evolves. Basically if you're treating something like strep throat for example with antibiotics, you are pummeling those bacteria and you do it really hard and really fast because the strep bacteria are just hanging out right in your mouth, in your throat. So you pummel them with antibiotics and they basically all die really quickly. So it's no problem. But with TB the bacteria aren't just hanging out, remember? They're really well hidden. They're covered in sacs of your immune cells and of tissue and they're infiltrated really deep into your lungs and they're slow-growing and they're hearty as hell. So you hit them with antibiotics but you have to keep hitting them and you have to keep hitting them and it takes so long that, first of all, not everyone is finishing their course of antibiotics, but also the populations of bacteria in your lungs are just living under this selection pressure for a really long time.
Erin Welsh	Right. All the susceptible ones are being picked off and all the resistant ones are staying and being allowed to reproduce.
Erin Allmann Updyke	Exactly and the chances that eventually one of these is gonna reproduce with some random mutation that allows them to be super resistant is just a lot higher because of the amount of time that they're able to sit there and reproduce. So essentially if you're under pressure from an antibiotic for this long and you happen to pick up resistance, then you're gonna be the one who's able to keep reproducing and then all of your friends are gonna die off and eventually all that's left are you and clones of you and then you end up with antibiotic resistance.
Erin Welsh	Yikes.
Erin Allmann Updyke	So the longer you take antibiotics in a situation like this, the more likely it is that something like this can happen.
Erin Welsh	Makes sense. And it's scary. It's very scary.
Erin Allmann Updyke	It's scary and it sucks and it's also so much more expensive to treat drug-resistant tuberculosis as compared to regular tuberculosis.

Erin Welsh	Okay I have a question.
Erin Allmann Updyke	Okay.
Erin Welsh	What are the most susceptible populations today?
Erin Allmann Updyke	Today for sure people who are immunocompromised are by far the most susceptible. So people living with HIV, children, and anyone who has any sort of autoimmune disease or other... If you're on chemotherapy, anything that would make you more susceptible to general... Oh, prison populations. Anywhere where you have crowding and not great sort of sanitation and access to nutrition and things like that. So it's definitely more prevalent in developing countries but it's also everywhere. I mean, TB is absolutely everywhere.
Erin Welsh	Uh huh. Yeah.
Erin Allmann Updyke	(trumpet sounds)
Erin Welsh	Okay so the status of TB today is, if I had a magic 8 ball it would be 'outlook not so good'.
Erin Allmann Updyke	Outlook not so great.
Erin Welsh	And that the WHO apparently needs to step up its game and actually practice what they preach.
Erin Allmann Updyke	I think yeah, it's interesting because they definitely do a lot of work on TB, it's one of their major focuses and I just really am curious to know, I don't know, does anyone work there? Like what are the gaps that are not... I'm very curious to know really what are the logistical hurdles that are not being met?
Erin Welsh	Mm-hmm. What are the biggest things standing in the way of actually reaching these goals?
Erin Allmann Updyke	Yeah. And is it just money? Is it just that they don't have enough money to treat all of these or to put the money where it needs to go?
Erin Welsh	Compliance with antibiotics.
Erin Allmann Updyke	Compliance is a big thing but the thing is you also see resistance developing in areas where you have really high compliance so...
Erin Welsh	It's just the nature of TB.
Erin Allmann Updyke	Exactly. TB is a gnarly one.
Erin Welsh	Yeah, it's not a disease of the past. At all.
Erin Allmann Updyke	It's not. It's not.
Erin Welsh	Okay well I think on that note we should read out our sources.
Erin Allmann Updyke	Let's do it.

Erin Welsh	I have a couple of books for you guys. One is called 'Invincible Microbe' by Jim Murphy and Alison Blank, and this is more of like a young adult book but I got it from the library and it was actually super accessible, easy to read, provided a great overview of the history and biology of tuberculosis. Another one is called 'The White Death' by Thomas Dormandy, that is the opposite of the Invincible Microbe in terms of its accessibility. Man, that author reveled in detail but it does do a lot of in-depth history. Another one is 'The Remedy' by Thomas Goetz and this is a really interesting book, so this is the one that explores in depth Koch, Pasteur, and also Sir Arthur Conan Doyle whom I didn't talk about but he was a physician before he was a writer-
Erin Allmann Updyke	I didn't know that.
Erin Welsh	And he was a science communicator. He loved to try to bring science to the public.
Erin Allmann Updyke	Wow! #scicomm. (laughs)
Erin Welsh	Yeah and this is why Sherlock Holmes was such a logically-minded, careful person.
Erin Allmann Updyke	Oh that's cool. I never knew that.
Erin Welsh	Yeah, scientific thinker. The last one is a book called 'The Plague and I' by Betty MacDonald and this is a memoir book written by this woman, Betty MacDonald, who went to a sanitorium in Washington state in the 30s I think. It is hilarious.
Erin Allmann Updyke	Oh. I was not expecting that.
Erin Welsh	It is so funny, she is so clever, so witty. It's full of great observant humor that is so ahead of her time. It reads almost like got a little flavor of Gilmore Girls, I really highly recommend it. It's got some great parts in it.
Erin Allmann Updyke	Oh. Cool! I should check it out.
Erin Welsh	And that's all I've got.
Erin Allmann Updyke	I obviously cited the WHO, they have the global tuberculosis report form 2017 so it's recent but also I got all the awesome, gory details on the clinical pathophysiology from this article called 'Tuberculosis: pathophysiology, clinical features, and diagnosis' written by Nancy Knechel. Nech-al? Sorry Nance.
Erin Welsh	(laughs) Run with it.
Erin Allmann Updyke	Published in the Critical Care Nurses journal. So yeah, that's all I have. A short list.
Erin Welsh	Cool.
TPWKY	(transition theme)
Erin Allmann Updyke	Well?

Erin Welsh	Thanks so much for listening.
Erin Allmann Updyke	Yeah thanks, this was maybe kind of a rough one.
Erin Welsh	Yeah.
Erin Allmann Updyke	Have an Alcohol Consumption.
Erin Welsh	Yeah we hope you learned something.
Erin Allmann Updyke	Yeah, I definitely did.
Erin Welsh	Yeah so did I.
Erin Allmann Updyke	So thank you also to Bloodmobile for the music as always.
Erin Welsh	As always.
Erin Allmann Updyke	Love it, love it.
Erin Welsh	And join us next week when we're talking about-
Erin Allmann Updyke	Yellow fever!
Erin Welsh	Oh yeah.
Erin Allmann Updyke	Oh I can't wait. Make sure you rate, review, and subscribe, we really love it when you do that, it helps other people find our podcast.
Erin Welsh	Follow us on social media.
Erin Allmann Updyke	Yep.
Erin Welsh	And wash your hands.
Erin Allmann Updyke	Ya filthy animals!