

## **Episode 19**

Ryan L.: Isn't one of us from Texas and would therefore say nuclear?

Patrick: It's, no, I'm from Tennessee and its nucular.

Ryan L.: Well, okay, there we go.

Charlie: Well, it's spelled N-U-Clear.

Ryan L.: -with big differences. But I think in the standard accepted format, its nuclear.

Charlie: Exactly. It's not spelled NUCULAR. So it's not going to be new-QU-lar. Nucular.

Patrick: It's like nucleus except with an R. Instead of an S.

Announcer: Hello, and welcome to science sort of.

Charlie: Welcome to Science sort of with me, Charlie, your host for this podcast and the usual suspects, the Paleo Pals. With me tonight. I have Patrick.

Patrick: Hey, guys.

Charlie: And Ryan.

Ryan: Hello out there everyone in podcast land.

Charlie: And today's theme is nuclear giants and ethical infants. This is pulled from a quote by the US general Omar Bradley, who commanded the troops in Normandy and he says that "the world has achieved brilliance without wisdom, power without conscience. Ours is world and nuclear giants and ethical infants." So we're not actually going to be talking about nuclear weapons or nuclear power. We're going to be talking about nuclear radiation and how it can both be used to cure and to cause harm.

Patrick: Ah, a double edged sword.

Ryan: Like podcasting.

Charlie: All swords are pretty much double edged. One edge is just duller than the other.

Ryan: But I guess a one edged sword would be a knife.

Patrick: The Japanese swords are one sharp edge.

Ryan: Those are just big knives.

Charlie: But we're actually talking about radiation. We're going to be discussing, ah, full body scans coming to an airport near you. Eco-preserve that is Chernobyl. And we're going to be talking about how exactly radiation causes living things harm. And so tonight we have a special guest and we're, this episode we have a special guest. Ryan Lipscomb, a medical physicist working at the John, John H. Stroger Hospital of Cook County Chicago. Ryan has a master's in medical physics from the University of Wisconsin Madison and a Bachelor's in physics from University of Washington Seattle. Say hello Ryan.

Ryan L.: Hey, guys.

Patrick: Hey, Ryan.

Ryan: Hello, Ryan.

Ryan L.: Patrick, Ryan, hey.

Charlie: So, purpose of the show is to discuss things that are science, things that are sort of science and things that wish they were science but to get our gears well oiled let's start off with what we have in front of us to drink. So Patrick, what are you drinking tonight?

Patrick: Oh, tonight, I am drinking coffee because I got more to do after we're done here. The night is young.

Ryan: Wow. Did you Irish up that at all?

Charlie: - grad student.

Patrick: Yeah.

Ryan: Really should have started with me Patrick.

Patrick: I do what I can.

Charlie: Yeah.

Patrick: Tonight. It's a little weak.

Ryan: I mean, last night you said you needed, or last show, you said you need to pick me up so you put Jim Beam in Coke. Is there any Jim Beam in the coffee?

Patrick: Negative there's there's no Jim Beam in the coffee. Just... coffee.

Ryan: All right. Moving on. Boring.

Charlie: Well, let's see if, let's see if our guest Ryan from Chicago can help recover.

Ryan L.: I'm drinking Two Hearted Ale from Comstock Michigan's to represent the Midwest.

Charlie: Nice,

Ryan: Nice. What kind of beer is that?

Ryan L.: Yeah, it's a good IPA. You guys are always drinking California IPAs. You know, Midwest needs represent quality breweries that we produce.

Ryan: Definitely. I had a great lakes beer the other week.

Ryan L.: Really?

Ryan: Yeah. Had an Elliot Ness, their amber lager. Yeah, was tasting

Charlie: Did the style of IPA change across the country? I know it changes from, like, America to England. Does it change?

Patrick: East to the west...

Ryan L: It does. I mean, the the hops that you can use are slightly different. And you don't get that, you know, wonderful cascade hops that you get out in the Northwest. But ah, but it's pretty fabulous.

Patrick: Yeah, he's turned out to be a great guest already.

Ryan: He can he can keep up with beer talk. That means he's legit.

Ryan L: Yeah. Thanks.

Charlie: All right. Ryan in Santa Cruz, what are you drinking?

Ryan: I am drinking a damnation golden ale from the Russian River Brewing Company up in Santa Rosa. California. This is ah, one of the best breweries in California. I almost poured it into a pint glass accidentally.

5:10

Charlie: What's the label of that look like again?

Ryan: It's got a pitchfork, stylized Pitchfork on it.

Charlie: Oh, right, right.

Ryan: That's a Black Label 7.75% alcohol and it's got, ah, it's supposed to be aged a little bit. I aged a couple of weeks, but probably not enough. Yeah, and I almost I almost poured it into a pint glass but it has a pint glass on it with a big x through it on the bottle. So you're supposed to pour it into a tool of glass. So I...

Patrick: I was about to ask you about the pint glass problem.

Ryan: Yeah, I was glad I noticed before I cracked open the beer could have been could have been bad. So this is a golden, it's a Belgian style golden ale from Russian River and they do some pretty fantastic stuff.

Charlie: As far as I can tell the pour is way more important than the actual glass you use So did you actually pour it properly?

Ryan: Well I haven't reached the bottom of the bottle yet. So that's where the pouring technique really comes into play. When you want to swirl the yeast, things like that. I will pour it correctly once I get down to the bottom.

Charlie: I see.

Ryan: It's pretty standard up until then.

Charlie: Well, tonight I'm recovering from a cold so I'm just sticking with a staple and that's a nice clean Pilsner, Stella Artois. And it's treating me right right so far.

Ryan: Here, here.

Patrick: An oldie but a goodie.Well, for you anyways.

Charlie: Yeah.

Ryan L.: Charlie, did you pour that into the official Stella glass? Or?

Charlie: No. And when I order at a bar, I asked them to, to pour it in a pint glass so I don't have to carry around that, that glass. I'm that self conscious, I guess.

Ryan: Wow. You really care.

Charlie: I do.

Patrick: Or not. Apparently.About the wrong things.

Charlie: About the wrong things. No, I'm drinking it straight out of the bottle. And the label is still intact, I don't have that. I don't have that nervous tic that a lot of people have where they rip off all the paper and leave it all over the place.

Ryan: I destroy a label.

Patrick: I, yeah, I'm the same way.

Ryan: I just can't help myself. My fingers need something to do.

Charlie: Alright, so we have coffee, an IPA, a Pilsner, and a Belgian?

Ryan: A golden ale.

Charlie: Golden ale, sounds good.

Music

Patrick: Charles,

Ryan: Snappy.

Charlie: Sorry, I'm so sick. Okay. So recently in the press, two cases of using CT scans inappropriately have come to light and these may have caused the patient harm. Both cases are in California. In Northern California at Mad River Community Hospital, CT scan of a child that should have it taken about two to three minutes to determine whether or not the child suffered any head trauma from falling off a bed actually went on for over an hour. So this this child may have been overexposed, or was likely over exposed to radiation. In Southern California, it's come to light that over the last year, 206 patients may have experienced overdoses from a CT scanner. And this this came to light because one of the patients was suddenly losing their hair.

Ryan L: Can I respond to that a little bit better?

Charlie: Yes, please.

Ryan L: So yeah, I mean, okay, so what I want to say is that in those two instances, that they're very different situations.

10:02

A regular CT scan is just purely searching for anatomical differences from the norm. And so you're taking one set of images over time. And that's what they're doing with with this kid who fell off the bed. CT scans on kids are something that we're, we're really careful about. And physicians tend to not prescribe CT scans for kids, except for in extreme cases, because of the cancer risk later in life.

Patrick: But is it a problem that, that say lots of parents who bring their kid in after they fallen off their bike or whatever, may, may push the physician to order a CT scan?

RyanL: Right. I mean, that's a, that's a whole separate issue of people wanting more diagnostic information that, then isn't necessarily what the physician needs to make a determination.

Patrick: Yeah, to make a good call.

Ryan L: Yeah. And that's really in the physician's hands, to, you know, stick to their ground on that one. But so, so that case was purely the tech's problem, where the tech should have just run the protocol straight through, it's very straightforward, a quick scan, a few slices here and there. And and you see whether or not there's an anatomical problem. The issue with the profusion of scans for stroke imaging, is completely different. It's much more dose by definition, because you're taking several images over time to watch how the blood flows through the tissue. And so in that, there's the inherent assumption that you only really do this with an elderly population that isn't going to really have that risk over the rest of their lifetime.

Patrick: Right.

Ryan L: And so, you by definition are imparting more dose. The problem is that if the procedure isn't set up correctly, you can use the wrong amplitude of energy or too much current and therefore too many photons and really give way too much dose. And you see that by the hair follicles dying, and losing hair, as in this case.



Charlie: So how does radiation cause harm? How does it, why does it cause hair loss in in higher doses like this, or maybe cancer over a long time for a child?

Ryan L: I mean, really, stop me if I go into too much detail here. But part of the issue is, is so we need to talk about what what type of radiation we're talking about here. And and in both these cases, we're talking about X-rays, which are photons of relatively low energy.

Patrick: It's the same, the same wave particles that we see in visible light, it just, it just...

Charlie: Yeah, I guess, what are the types of radiation? They're the X-rays, gamma rays, those are all just different frequencies of light, but they're also things like alpha particles and beta particles, and what are all these different things?

Ryan L: Right? That's, that's really good question. Um, so alpha particles are particularly interesting. It's actually, an alpha particle is essentially a helium nucleus, which is given off during, ah, during a nuclear decay, a radioactive particle. X-rays are given off when an electron in this case, like, like, all the X-ray generators, when an electron hits a tungsten target, it then emits a photon of a specific wavelength that we've determined to be an X-ray.

Charlie: I see.

Patrick: And so then how did how did these, so for example, X-rays, how would they wind up doing damage over over time, or if you get too high of a dose?

Ryan L: Right, right. So that's a good thing. X-rays, X-rays, and all these sorts of things we're talking about are types of ionizing radiation. Which means that what they do when they interact with matter is that they ionize the molecules or atoms, and each give electrons off of them. And so that disrupts the bonds between these molecules. Where really causes problems is that in the cell, when it hits the nucleus, it can disrupt genetic material and change the genetic code, which, in many cases, just kills the cell, which is when you see the hair follicle dying, or it can cause cancer by disrupting that genetic code, and then causing mistakes to be made in the replication later on.

Charlie: So it breaks down the fundamental chemistry that that is in our cells, in a sense, by breaking the bonds between the molecules.

Ryan L: Well put thanks. Yeah.

Patrick: So in your estimation, Ryan, is there a bigger risk for say, developing cancer later in life or a bigger risk for passing on some kind of mutation? When you have kids?

Ryan L: It really has to do with developing cancer later on in life because you, you're almost never radiating into gonads, or any sort of reproductive organs, right?

Ryan: I mean, maybe that's not how you spend your weekends. But I'm always after reading Marvel Comics for years, I'm always out there trying to get bitten by radioactive spiders and standing in front of experimental bombs and taking untested spacecraft up into the atmosphere to expose myself to radiation. Eventually, one of these times I will get superpowers.

Patrick: Well, it's it sounds more like you...

Ryan L: That's why I went into medical physics to begin with, you know, I was hoping to get a little extra dose and maybe become a superhero. Or a villain, either way.

Ryan: Or a villain.

Patrick: Well, I guess there's still hope for your offspring if you're out there...

Ryan L: Hopefully...

Patrick: Dosing your gonads.

Ryan: That's what happened with Beast from the X-Men. His dad, his dad worked somewhere where he was exposed to a lot of radiation. So that's why Beast was born the way he was.

Charlie: Why are gonads so sensitive.

Ryan: Because they're just dangling there. Obviously.

Ryan L: Hanging out on the outside, they're just asking for it.

Ryan: It's something about intelligent design and putting your most sensitive equipment right there to be and kicked.

Ryan L: That way...

Ryan: It's perfect kicking,

Charlie: Is it because there's like a million sperm cells being made all the time. And so there's these they're quickly being produced or whatever? Is that why they have trouble and does, like, a radiation dose to to the gonads cause permanent damage to your sperm forever? Or just for like, the next few months? Like taking a hot bath might screw you up to but is it different than that? Ryan: And skinny jeans. Don't forget skinny jeans.

Charlie: Yeah.

Patrick: And laptops on your actual lap.

Ryan: It's where they're supposed to go, Patrick. I always wear protection. Whenever I put my laptop on my lap. I have a special codpiece with a fan.

Ryan L: What kind of protection, exactly, are you wearing?

Ryan: A codpiece with a fan. I really, I can't avoid going to this joke now, but it's like I'm always getting blown.

Patrick: Really didn't spring for the liquid cooled model? Ryan: No, no, liquid nitrogen. I didn't want things to get brittle down there. Sorry, I didn't mean to completely derail the actual science talk.

Patrick: Charlie had kind of a real question.

Ryan L: Charlie did but I just didn't really want to answer it so.

Laughter

Patrick: We can move on.

Charlie: No problem.

Ryan: So, explain why, why Bruce Banner would have just died instead of becoming the Incredible Hulk.

Ryan L: Well, we can't we can't really...

Ryan: Get Stan Lee on the phone.

Charlie: So what is, what is the future hold for this, this poor kid up in Mad River that got, that experienced the CT scan for over an hour?

Ryan L: Well, that's a really good question. I mean, the thing about all of this sort of interaction, is it's all, it's all stochastic. So everything that we really know about it is, is probabilities. And with that much dose at a the young age, he has a higher probability of developing cancer later in life. Probably, you know, in the area that was scanned, which would be the brain. But hopefully, that...

Charlie: Huh. Now, these, these CT devices are in a hospital for a good reason, I presume. They're not just there to cause patients harm. So what do they do that, that helps. What, why are they medically beneficial? Why, if a doctor suggests that I get a CT scan, I should say, okay.

Ryan L: So there are lots of good things you can do with CTs. And, basically, anytime you get any sort of test done, especially an imaging test, there's a certain inherent risk to it. Ultrasounds can cause damage. So that's a really small risk. MR scans, there's a little bit of uncertainty as to what that effect could have on the human body. And CTs are a little bit better known in this whole ionizing radiation risk. But ultimately, what it comes down to is the risk of not knowing what the medical problem is. It could be more immediate, such as, like trauma to the brain, or a stroke, or, you know, cancer somewhere, we use CT scans to screen for cancer in

patients to present with symptoms that might suggest it and things like that. So really, what you're doing is, what your doctor's doing as a risk/benefit, sort of analysis about...

20:22

Charlie: I see.

Ryan L: ...what they could find, versus, you know, what, what kind of harm they would do and looking for it.

Charlie: So the doctors like, I think this is wrong with you, we need to look into your body. And it'd be much easier to use a CT than actually, and much less invasive and damaging to use a CT rather than to open you up. And so it's something that's performed when there's already, already cause for concern, and you just want to assess what that concern is and how to best treat it after more knowledge is obtained about it.

Ryan L: Exactly. And this is all evolving, you know, very rapidly as far as, this is all evolving very rapidly as far as how much information we can get, and how much dose we impart to get that information. There are all sorts of advancements, particularly in profusion imaging getting all that information while using fewer X-rays to impart less dose. And so really, what we're trying to do is is, is image this anatomy and physiology and get a better idea about how the body is functioning and where it's functioning well, and where it's functioning less well, and guide medical procedures from that. Yeah.

Ryan: Cool. So, is the CT scan what they're using or going to be using in the airport? What's the situation with that?

Charlie: I think that's, I think that TSA just wants to look at people without their clothes on, right?

Patrick: I guess, I guess we know what the, I guess we know what the T and A stands for in TSA.

Music

Ryan: I would save them the trouble. I always go to the airport naked. I don't know what the problem is. Like I still wear shoes and a belt just so I have something to take off when I stand in line. But that's it.

Charlie: And an iPod.

Ryan: Well, yeah, of course, I guess the...

Patrick: And a laptop and a camcorder with cassettes.

Ryan: Yeah, well, those are all in bags. And I just take the bags off. And then I just I walk through the metal detector naked, and then put my flip flops back on put the belt back on, the iPhone holster. And, yeah, I'm super cool looking in an airport.

Charlie: So what are those machines? What are they doing?

Ryan L: I don't actually know the geometry of how they work but a CT scan isn't really all that different from an X-ray. It's just the geometry and then the fancy mathematics that go after that, but basically, the difference between these photo scanners at the airport and the medical devices, is that the medical devices, we're looking at X-rays that travel through the entire body and then get detected on the other side. Whereas these full body scanners at the airports are looking at X-rays that really only go, you know maybe a centimeter into the body and then scatter back to the detector near the source. So you're looking at sort of X-rays sort of bouncing off of the body, and therefore you can see what's underneath the clothes. What's at the surface of the body if anyone has something tucked in their underwear or something that...

Patrick: Well what if I'm wearing, so if I wear, like leather pants, is that enough to stop it?

Ryan: Or lead pants.

Patrick: Well, I'm sure lead pants would work.

Ryan L: Well, I'm sure lead pants, definitely.

Patrick: I mean, so.

Ryan: But no, I mean, the leather is going to be thin, it's not really gonna...

25:01

Ryan: I don't know you've never seen Patrick's leather chaps. They're pretty thick.

Charlie: Stop a chainsaw.

Ryan L: So that, that... yeah.

Patrick: I had another question. I can't remember if it was comedy or real?

Ryan: Because now you can think about is a chainsaw attacking your legs while you're wearing leather chaps?

Patrick: Yes,

Ryan L: Exactly.

Patrick: Oh, oh, it was real. So these, I guess, I guess they're weaker X-rays, then if they're bouncing off, you know, the upper centimeter of your body. You know, some people fly weekly. Are they gonna die of cancer for sure or are these so weak that that's not really going to be an issue?

Charlie: Or just die of airport food?

Ryan L: Right. I, no, I mean, no, I would say this, the ah, the dose that is imparted is so small that I think the reports said it, there was a report that came out not too long ago, I think, by the National Radiation Safety Council, that estimated the amount of dose that a person traveling in their lives would get from one of these things and there was something on the order of magnitude, of like 2500 scans would get you to the level that the general population is allowed to get a dose a year. And it was the equivalent one of these scans, was equivalent to about two

minutes of flying in an airplane. Because quite frankly, flying in an airplane, you know you're up much higher in altitude you gain a lot more solar radiation, you actually get a fair amount of dose.

Patrick: So you definitely are going to, you're definitely going to die of radiation it's just not the radiation in the airport, flying every week.

Ryan L: Exactly.

Ryan: Or get superpowers we still haven't ruled out superpowers.

Charlie: Not ruled out at all.

Ryan L: The issue is, how many airplanes, how many airplane pilots have superpowers, that we know of.

Ryan: They've probably never been bitten by a...

Charlie: I know of at least one, Captain Sully obviously superpowers of some sort.

Ryan: True.

Patrick: Is that the Hudson River guy.

Ryan: Yeah.

Charlie: Well he did that but then then to be on like every then to be on like every talk show and Super Bowl and concert ever since that event, that takes superpowers too.

Ryan: The Super Bowl is no pressure for a man who landed a plane in river.

Patrick: Didn't somebody say the real superpower would have been to put it on the runway, like the river, not supposed to be where you land.

Ryan: Yeah, you know what that was a geese's fault. And he doesn't have the power to control geese. He's not, he's not the Aquaman of the sky, Patrick.



Patrick: I'm thinking I might be able to land a plane in a river.

Ryan: Sounds like another Science sort of field trip to add. How much?

Ryan L: That sounds like a good experiment.

Ryan: How many books do we need to be bought from Amazon before we have enough money to rent Patrick a plane to crash in a river?

Patrick: I think we just go with the myth busters do this one. Is it easier to land a plane in a river or a runway?

Ryan: Crossover episode.

Charlie: I had one last quick question before we move on from radiation and the harm it causes. Now why is it that certain doses, like, can kill you right away or within a within a few weeks. So like two years ago that Russian spy got dosed with polonium. I think his name was Litvinenko. And, first off what is polonium and why, why was it so effective at assassinating him in, in only three weeks.

Ryan L: Right. Okay. So this was kind of an interesting question. I actually had an exam in grad school that had to deal with this particular situation.

Charlie: That's a dark professor.

Patrick: Yeah.

Charlie: Or a cool professor.

Ryan L: It was definitely...

Patrick: Did you graduate, graduate with two zeros in front of your name?

Ryan: Solo Lipscomb

Patrick: Yeah.

Ryan L: So, so polonium, polonium 210 is, I think we talked a little bit about the types of radiation there are. So polonium 210 decays, in its main pathway, with an alpha particle, which is a helium nucleus with a lot of energy. And that's a lot different than an X-ray because the mass of an X-ray is, is tiny compared to the mass of an energetic helium particle. So you've got this helium nucleus traveling and depositing dose in a very local area but, but this was dispersed, because I think, if I'm not wrong, he drank tea that was laced with polonium 210.

30:05

Charlie: Yeah, he was assassinated via tea pot.

Ryan: That's the British way to die.

Ryan L: That's a very deadly tea party. So, so what happens is, is I think what's important to talk about here is the difference between, like, radiation dose to a specific cell and radiation dose to organs or systems, right. So we can't survive with our organs shutting down, our whole, like gastrointestinal system, shutting down. And what you here, what you have here is that he had 200 times of lethal dose of polonium 210 in his body. And so, just, throughout his entire body he was being attacked by these helium nuclei, slamming into his cells and killing large amounts of his organs and systems, And the body just cannot handle that much cellular death on a large scale. So that's where you get this acute, very drastic response to radiation, as opposed to having some hair follicles fall out or later in life having cancer risk increases, because that's more specific cells rather than whole systems or organs.

Charlie: And so it made it look, made him look like he aged super fast. Is that just because the cells couldn't replenish themselves, they weren't able to copy and and make new cells.

Ryan L: Well, essentially, I think that, I mean, if you had, like tons of yourself dying you probably age pretty quickly, you know?

Charlie: Right, right.

Patrick: Like a fine wine.

Laughter

Ryan L: Yeah, I don't know if I answered that question. I mean, I guess solar radiation does that to you right? I mean...

Patrick: Yeah, I guess so.

Ryan L: ...if you hang out in California in the sun for too long doesn't look too good in a few years.

Patrick: Ah, but if you're there you just get it clipped away, tucked away, lifted...

Ryan L: Lifted and pushed, yeah. Exactly. You get stem cells injected that make it all better, right?

Patrick: Yeah, that's where we're headed.

Ryan: Are we also headed to Trailer Trash Talk.

Patrick: Either that or Cherobyl. I don't know which.

Ryan: Well, you know, the, the spy was killed in Britain and there's another famous Briton who's got a movie coming out about him.

Music

Announcer: Hey, y'all, it's Trailer Trash Talk.

Patrick: So this week's Trailer Trash Talk is a movie that could possibly be near and dear to the Paleo Pals heart. And that is *Creation, the True Story of Charles Darwin*. And, this I can't remember who directed this, but it's starring, ah, Paul Bettany, and Jennifer Connelly. Paul Bettany was, actually, played, I don't, I don't guess he actually played Darwin, but he played almost Darwin in *Master and Commander*. Is that right?

Ryan: Yep. Yeah.

Patrick: So this is kind of weird for me to see him again as actual Darwin looking exactly the same.

Ryan: All English naturalists at that time looked the same Patrick.

Patrick: Yeah.

Ryan: They evolved to look that way.

Patrick: Anybody got the ah...

Charlie: Yeah, it's directed by...

Patrick: ...on the director?

Charlie: Yeah, it's Jon Amiel.

Patrick: Right. So the premise of this movie, follows the story, less about Charles Darwin sort of puzzling and figuring out how the theory of natural selection works, as it as it pertains to evolution. And more about his apparent struggle with what it had to say about whether there is a God or not. And Jennifer Connolly plays his wife, and she really has reservations about how reconciling her husband's theory and her belief in God. And so that seems to be the tact this movie is taking, more than oh, look how smart Charles Darwin was, it's like, look how conflicted he was.

Ryan L: I don't know. To me, it seemed like it had a lot to do with like, oh, hey, we've got a build around Darwin's life and the conflicts and the relationships rather than what the actual science was, and how his mind was working and doing through it.

Ryan: But those conflicts were real. I mean, it's not it's not historically inaccurate to say that him and his wife had problems over this. That's pretty clearly shown in the historical record.

Yeah, that seemed to be the case. And I guess his daughter, his daughter dying, somehow inspired him to publish his work.

Ryan: That and Alfred Russel Wallace.

Patrick: Yeah. Yeah.

35:00

Ryan: His daughter died. And then he almost got scooped. Yeah.

Patrick: And then he got a letter saying, you know, I think I've got an idea about how evolution might function here. What do you think about this? Darwin was like I better get that out the door.

Charlie: Right.

Ryan: But his wife, I mean, I've, you know, I've heard a lot about this. And his wife was very religious. And she did have problems with the theories. But he actually gave her all of his, they show it in the trailer, but in real life, he did give her all of his manuscripts and basically said that, like, if something happens to me before I can publish this theory, you know, I trust you to do the right thing. Yeah.

Ryan L: Wow.

Ryan: So it seems I mean, I think, I think, I don't know how much they're going to romanticize it. I mean, it's a PG 13 movie about Darwin and his wife, but the historical basis is there.

Laughter

Charlie: What does that even mean?

Patrick: I don't know.

Ryan: Tease it out for yourself. It means Darwin can only drop the F bomb once.

Patrick: Right.

Charlie: I see.

Patrick: And Jennifer Connelly can only get naked if it's she's posing for an art scene.

Ryan: Yeah. Right. And I don't think I mean, you know, it's been a while since I've flipped through Origin of Species, but I don't remember any drawings of Darwin's wife in there. So I don't think we're going to get that scene in the movie. But what did you guys think of the actual trailer? Do you want to see this movie now?

Patrick: It looked more like a Lifetime movie.

Ryan: It did.

Charlie: Yeah, it did.

Ryan L: But I actually want to see it, like, strangely enough. I don't know if it's just because it's a period piece. Or if it's just because it's about, you know, Darwin, but it did make me want to see the movie. I have to admit.

Ryan: That's good. Okay, so yeah, but, I thought it was, I thought it was funny how they have all these religious figures asking Darwin questions at the time that had become the staple arguments of creationism. You know, like, well, Darwin, if your theory is correct, that means the six days of creation don't work. It's like, yeah, that's pretty much exactly what it means and people should stop bringing that up. But I also liked all the imagery they had with Darwin touching the finger of the chimp like, like the God touching Adam's finger and Michelangelo's.

Patrick: Yeah, except that wasn't sure exactly, what I was supposed to glean from that imagery, like, what does that really mean?

Ryan: It means Darwin created life. That's why that's why we're not evolutionary biologists. We're Darwinists. We worship at the altar of Charles Darwin. He is our here's our Lord and Savior.

Patrick: Oh, wow.

Ryan: Yeah, you didn't know that, Patrick?

Patrick: No, no, I'm not on the I'm not officially a skeptic. I guess. I didn't realize that.

Ryan: Ouch. All right. Well, are you officially thumbs up or thumbs down on this movie trailer?

Patrick: I, like Darwin, am conflicted here. I'm glad they're making a movie about Darwin. That's pretty cool. It's possible I'd go see it. So, maybe a weak thumbs up in that category. The trailer itself? Not especially a great trailer, in my opinion. So I'm doing thumbs down. I might give up a weak, a weak long on this one.

Ryan: Charlie?

Charlie: Um, yeah, I wasn't terribly impressed with the trailer. But I do very much like the story of Darwin and, and what he's contributed to our knowledge of, of life on this planet. But I think I'm going to save this for the, for the home and not see it in the theater. So I'm going to give a thumbs down on the trailer. And Ryan?

Ryan L: I don't know I mean, I, I like the rest of you guys are, kind of conflicted on this whole thing. Um, I would have to say personally, I'm probably not going to see it in the theater, I'm probably gonna like Netflix, Netflix it but um, but with the whole controversial, in the United States evolution issue, I'm probably going to go with long in that I think that is going to cause controversy, and therefore people are going to go see it.

Patrick: Other Ryan?

Ryan: Um, I didn't really remember *Master and Commander* well enough to make the associations that you made Patrick. So I'm kind of curious to see his portrayal of Darwin. I don't know that I've ever seen a popular press movie media portrayal of Darwin. And Jennifer Connelly is, is one of my she's on my list of very attractive people that are attractive. And I like Darwin, so I'll... She's what?

Ryan L: I said that's why we go the movies. So yeah.

Ryan: Yeah, pretty much, pretty much. So I'm gonna I'm gonna give this a thumbs thumbs up as well. She was also in the Hulk movie, the original Lang Lee one. So there's, there's another connection to radiation.

Patrick: So thumbs up. Let's see.

Ryan: I'll give it a thumbs up. Why not?

Patrick: Okay, fair enough. I'm not sure exactly where that puts it. I think we're gonna go like 65% longish.

40:07

Ryan L: Does that work with four people?

Patrick: It's more complicated with four people. But the math kind of works.

Ryan: Patrick will take care of us.

Patrick: Yes.

Music

Ryan: Ah, speaking of doing other things that get you damned for all eternity, let's talk about Chernobyl.

Patrick: Excellent segue.

Ryan: Thanks. Um, so my my pic of beers this week was damnation. And I have to admit, I was going a little more meta, than usual, with my beer pick. Because this week, Charlie asked me to do a little bit of research on the ecology of Chernobyl. And that's exactly what I did. One of the, one of the interesting things I recently learned about Chernobyl is that Chernobyl, translated into English means Wormwood. And Wormwood is in the book of revelation from, the Bible, the name of one of the angels, that falls from heaven, and, and causes men to die and makes water bitter. So there are actually some, actually some people out there that have



pointed to the Chernobyl accident as part of the prophecy of Revelation in coming true because the star, a star falls from the sky, and if you pick them up a runaway nuclear reaction, yeah.

Charlie: So that may be a bit of a stretch. I mean, Chernobyl means dark grass.

Ryan: You're saying, you're saying, fitting a biblical prophecy to real world events is a stretch?

Charlie: No, I wasn't saying that at all, never mind.

Ryan: Good.

Charlie: I take that back.

Ryan: Moving on.

Ryan L: I thought you were... Charlie

Ryan: So I referenced a couple of articles. As far as I can tell, there hasn't been a whole lot of research done on Chernobyl and what the ecological effects are, there are still animals living there, there are still people actually living there who refused to leave. The actual mortality rate is up for debate, was originally pinned at about 9000. But some other groups have argued that it should be higher. So it's 9000 people who will die because of the radiation, that were exposed.

Patrick: Yeah, but but in general, the place is not a wasteland. Like you go there, and there's plants on on the ground, and there's there's animals running around, and even some of the top predators like bears and wolves have moved back in.

Ryan: Yeah, I mean, it's probably better for the rest of the ecosystem that humans have generally left.

Patrick: That was, right, that was one article I read...

Ryan L: Generally, you see, like deer, and those sorts of things have a much shorter lifespan than they do other places, right?

Ryan: I don't know that.

Charlie: Yes, some animals are affected. Some, some of them are not. Swallows, for instance, are having some trouble, but but rats are doing just fine. Apparently, they don't feel the radiation much at all. But uh...

Ryan: Well, and there's one, there's one organism that does more than just not feel the radiation. There's one organism that takes advantage of it, and there's a fungus...

Patrick: Aw, I thought you were going to say naked mole rats...

Ryan: Well, I mean, they're probably doing just fine. They could probably survive this no problem. But I don't know if they've exposed naked mole rats to radiation, that could be a grant.

Ryan L: Oh, they...

Ryan: Okay, good. I'm glad somebody's exposing them to radiation. But what I was referring to was the fungus. So there's actually a fungus living inside the reactor. So we're not talking just in the Chernobyl area. This thing is inside the reactor where it all all went down. And this fungus is a member of a group which is going to become our Paleo WOW, which is our Paleo Word of the Week, which is something I just made up. Because people, people always say that we we use big words on the show and then explain them. So this will be your paleo, this will be the word to WOW, your friends with. So, your paleo WOW of the week. Your Word of the Week. WOW, think of that.

Patrick: Bacon.

Ryan: So the word is radiotrophic, which means that's something that feeds on radiation. So, yeah.

45:00

Charlie: Videotrophic.

Ryan: videotrophic focus,

Patrick: I would argue that all our listeners are radiotrophic, because they're feeding off our radio.

Ryan: I suppose you're right. So um, I've mentioned, I mentioned...

Ryan L: ...look it up. I mean, it's, is photosynthetic radiotrophic, so...

Ryan: Well, photosynthetic refers to a specific biochemical reaction that occurs in a chlorophyll that a plant contains. So I suppose you might be able to argue that, that photosynthesis is a subset of radiotrophic, but radiotrophic in this context, specifically refers to things that are feeding off of radiation.

Patrick: And they're not really eating radiation. They're eating CO<sub>2</sub>.

Ryan: Mmmhmmm. Yeah.

Charlie: Yeah, sounds like semantics to me.

Ryan: Right.

Ryan: L: Oh, come on. I mean, photosynthesis is like, you know, just different type of radiation, you're, all you have is a different energy wavelength.

Patrick: Yeah, but you're not eating that you're not eating that energy, you're eating

CO<sub>2</sub>, you're just using using that energy to help you harness CO<sub>2</sub>.

Ryan L: Okay, I differ to you guys.

Ryan: No, no, I mean, that's a legit point. I just, I think it does come down to a little bit of semantics. But these, you know, I think photosynthesis, specifically refer to things that have chlorophyll and this is a fungus, and it doesn't contain chlorophyll. But the article actually does reference photosynthetic plants. But it says that just as they use chemical energy from the sunlight, these are using a different portion of the electromagnetic spectrum, which is the ionizing radiation that we talked about

earlier. They found that when they put this radiation in, or when they put this fungus in a container exposed to radiation, ionizing radiation, 500 times higher than background levels, they grew much faster.

Ryan L: Okay.

Patrick: So they, they actually do have superpowers.

Ryan: I mean, I've referenced the Incredible Hulk a couple of times, but this is the this is the Incredible Hulk fungus. It feeds off of gamma radiation and gets bigger and angrier, and it's going to kill us all. If only it was green, it's black. That's the only thing that really bugs me.

Ryan L: So Ryan, I was gonna ask you, do we actually know, the like, chemical pathway by which this is happening?

Ryan: The articles I looked at, which are just popular press articles, which I will post on the the show notes, as always don't actually explain anything as complex as the chemical categories. If I had had time to do more research, I maybe could have found that. I think I mean, I think this is a relatively unstudied phenomenon. This article was from 2007. So it's relatively recent. I remember hearing when this fungus was first found is kind of a big deal.

Ryan L: It definitely sounds like a huge deal.

Ryan: Ah, the fungus also contains melanin, which was surprising. It's the,

chemically, the same pigment that colors your skin. They have a lot of that and it seems to provide some kind of benefit to their life cycle.

Charlie: Well, maybe that's part of the chemical pathway.

Ryan: It's possible that melanin has something to do with it. Yeah, so basically...

Ryan L: It could be...as well.

Ryan: Yeah, they they believe that the melanin, there's something about the radiation that's affecting the electron structure of the melanin, which may be part of the step that captures the radiation to convert it into biological energy.

Charlie: So these things actually live off radiation. Now, a big problem with space travel is, is the radiation that the astronauts will get when they travel somewhere further than, than...

Ryan: Well, that was...

Charlie: ...just the moon. That, like maybe going to Mars. So could they could they use this to block the radiation and then like, make a nice like a pasta wine sauce for it?

Patrick: Aw, man, That's gonna be so awesome when you have, like, a fungus suit.

Ryan: So that's actually mentioned in the article, Charlie, and I was saving it to because I knew you would love to hear it. Basically, they, they, it says right here in the article, "radiation munching fungi could be on the menu for future space missions". Ionizing revelation, man, I can't talk revelation, ionizing radiation is super prevalent in outer space. So if you could get this fungus to grow, you could have an inexhaustible food source.

Charlie: Whoa.

Ryan L: If it weren't toxic.

Patrick: Is it tasty? Yeah.

Ryan: I don't know that anyone's tried eating the Chernobyl radiation yet. But it would be cool if you could create, kind of, a layer of it lining the, you know, inner and outer hull of the spaceship that was kind of a radiation sponge. Because it would probably be a lot lighter than lead, which would be hard to launch into space.

Ryan L: Yeah, but once you got it there, it's no problem.

Ryan: Once you get up there, maybe it maybe there's lead on the moon, we could mine it. And that would, that would help. But yeah, so that's, that's what's going on At Chernobyl. The fungi will one day rule us all. And you're listening to fun guys right now.

Charlie: But apparently, also, there's all sorts of other species that are not necessarily benefiting from the radiation but benefiting from the absence of humans that the radiation is causing.

50:08

So there's just like, this 500 square kilometer danger zone, that's, that's been designated over there, that humans aren't really supposed to be there.

Patrick: I mean, they're not supposed to be there for the next half million years.

Ryan: But they are, there are people there.

Patrick: But that isn't, that's amazing that like, you're not, like another half million years. Really, humans aren't supposed to go there. But there's wolves running around.

Ryan: There are people live in there too.

Charlie: There's, there's species that haven't been seen in any sort of like

sustainable numbers throughout Ukraine that are now there, like lynxes, wolves, bears all sorts of things.

Ryan: And so you're saying you're saying in Greenpeace or PETA or any of those organizations that want more animals running around, they should just go start sabotaging nuclear reactors?

Patrick: You know, I was thinking about it. Not doing it personally. But you know, that might not be a bad thing to do if you were trying to protect some land.

Music

Ryan: Speaking of irradiated freaks, our listeners have written in.

Charlie: They have indeed.

Patrick: I think you mean I think you mean radiotrophs.

Ryan: Oh, yes, speaking of radiotrophs , radiotroph methanogens. The Paleo posse has been in touch. So the listener feedback has been rolling in, we've been getting more of it than it's possible to go through in a single episode. So we came up with a new system and that system is called the Paleo POW which stands for Piece of Work. So that each week, every three, or are all the Paleo Pals will pick their Paleo POW of the week. We're going to give partial credit to this idea to Gregarious, who titled his iTunes review, Paleo Pow, which was a phrase we liked so much that we're trying to incorporate it into the show. So guys, you want to you want to start us off and give us your Paleo POW of the week.

Patrick: Sure, I can start. Mine is sort of twofold. And it comes from the land of Facebook. And I'm Elise Wagner wrote in and said, "the podcast is great. Fun and full of all the right stuff, Fun banter, interesting articles and discussions, accessible and provocative. I'll listen all the way to 2012 and beyond if the world decides not to end." So that was very, very kind words. And then I also like this response later on in the conversation from Dan Combs, it said, "great podcast this week, guys. The East Tennessee interview rocked, keep them coming." And I appreciated that because I just barely pulled that East Tennessee State interview together, and it almost fell through but then it happened. And so I'm glad someone out there.

Appreciate it. Thanks, Dan.

Ryan: All right. And Charlie, what about you? What's your Paleo POW the week?

Charlie: My favorite Paleo POW comes from UtahLesay and she writes to Justin on his comment page on the website, "You and Charlie have a very calming effect on what could be the crazy Ryan show. I love the podcast and the balance of personal relationship plays very well on the interwebby contraption." She cites that as a technical term. Pretty cool. Thanks. Thanks UtahLesay. I'll do what I can to keep the crazy Ryan show at bay.

Ryan: I actually responded to that on the website because I agree that I want you guys around because I don't want this to be the crazy Ryan Show. I want it to be the Paleo Pal Science sort of show featuring crazy Ryan.

Patrick: Prominently featured.

Ryan: And for my Paleo POW this week, I picked a review that was left for us on the Podcast Alley website from Neverheiday. I really, I don't know how to, yeah, I was in my head, say Never-Hide-Ah. But I don't think that's correct either. Um, what he had to say was "so much love for Science sort of. God I love this show. I've been listening since the first episode but truly got hooked on it after the episode where they discussed the viability of microbial life in a gin and tonic. A hypothesis, which they later hilariously tested. More fun for all you science, nerdy sciencey, people out there. And a familiar format for anyone who ever shared a lab studio workspace with other nerds in the wee hours in the morning. I also recommend following their Facebook and Twitter pages, which are equally entertaining. I'm glad somebody's giving a shout out to the Facebook and Twitter pages because we do post more than just show notes and show announcements. We use those to have a conversation with the Paleo Posse at all times. It's a lot of fun. Yeah.

55:08

Patrick: Very nice.



Ryan: Real quick, before we wrap up entirely, I want to touch on the Podcast Alley contest I announced last week, which I don't think I thought through all the particulars quite enough to make it feasible. I said that people who voted for us on Podcast Alley, and left a review such that I was able to figure out who you were would get prizes. And that still holds that's, that's true, you'll get your prize. But unfortunately, the show that's beating us, *The Naked Scientist*, which is a good show, but don't, don't download it, I just, to keep their numbers down. They got, also got more votes. So they are beating us by more than 10. Now, so getting the 10 votes that I asked her last week wouldn't quite cut it. So here's my plan, because this show's probably not going to come out until next week, which will be like the 25th or the 26th of January. If you haven't already voted on Podcast Alley, if you if you'd like to go ahead, I'm never going to ask you to stop. But you can vote once a month. So let's let's Blitz them on February 1 and get the number one spot

instantly. So, here's the thing, I got bonus prizes I got, I got the main prize that I'm going to send out to everyone who voted so far in January. And then if you hold off until February or if you vote in both January and February, you're going to get the bonus prize. If you already voted in January, don't worry if you vote again in February, you'll still get the bonus prize. And that's that's my pledge. And as soon as we hit number one, everyone who got us to number one's gonna get that prize. I got an email today, asking if the prizes were real. They're real. They're going to happen.

Laughter

Ryan: I did I got an email. Somebody didn't think there prizes and there really are.

Patrick: They are real. It's true.

Ryan: I again, I don't want to say what the prizes are. I will point out that over over Christmas break, or over the solstice break, I did go to the Creation Museum in Kentucky. And that's all I'll say.

Patrick: You know, I think, it's clear to me now that there is a double agent in the Paleo Posse. Someone is also a member of *The Naked Scientist Posse*.

Ryan: They warned them about the coming onslaught of votes.

Patrick: Yeah, exactly. It's time to break out the polonium.

Charlie: Yep.

Ryan: Well, they, will, yeah, the naked scientists haven't had that many votes for, for January. I think we can Blitz them on February and make it make it work. I think we I think we can do this. I think the Paleo Posse is an organized enough monster at this point.

Charlie: Excellent.

Ryan: Cool. So I think we've covered all the bases talked about Podcast Alley, iTunes reviews. Facebook, Twitter.

Patrick: Yeah.

Ryan: Paleopals@sciencesortof

Patrick: Why don't you throw out our phone number, and let's call it a day.

Ryan: So if you'd like to get in touch with us with your own voice, and we will cast that voice into the podosphere. You can call 312 Paleo Pals, which is 312-725-3672 to and we will play that voicemail on the air.

Patrick: Excellent.

Ryan: Yeah.

Patrick: Well, it was fun, as always.

Ryan: It was a heck of a show this week, guys.

Ryan L: Thanks for having me guys.

Ryan: Yeah, Ryan, thanks for being on.

Patrick: Thanks for being on, yeah.

Charlie: Yeah.

Ryan: It was great talking to you, Ryan, you are knowledgeable about things that we are not knowledgeable about. And that's exactly why you're here.

Charlie: Alright, well, thank you for listening to Science sort of. We hope we didn't overdose you with our talks on radiation this episode. And look forward to... I'll just edit with we hope you didn't overdose.

Laughter

Announcer: Thanks for listening to Science... sort of. Our show notes are available at [sciencesortof.com](http://sciencesortof.com) which will have links to all the stories we talked about today. You can follow us on twitter at [twitter.com/sciencesortof](https://twitter.com/sciencesortof). You can get in touch with us at [paleopals@sciencesortof.com](mailto:paleopals@sciencesortof.com) or on our Facebook fan page. A great way that you can support the show is by subscribing to our feed on iTunes and writing a review so other people have a better chance of finding the show. And if you have a friend who you think might be interested tell them to give us a try. That's all for this week, thanks for listening and see you next time on Science... sort of!

Charlie: Alright, after 123 we'll say 123123123.

Charlie: All right. Welcome to Science sort of, Episode 19 with me Charlie, your host for the, for the, goddamn it. It's not the evening for everybody.

Ryan: They can listen to it whenever they want.

Charlie: I'm not sure what else he's directed. I'll try to look that up now.

Patrick: Yeah, so I mean the... (disconnected tone).

Ryan: Oh, we just lost Ryan.

Patrick: Yeah, we did. Charlie...

Ryan: I don't know what's going on. Charlie's not picking up.

( Phone ringing sound)

Ryan L: Hello. Wow, this is actually working this time.

Ryan: Oh, the Skype.

Ryan L: Okay. Yeah.

Patrick: Sweet.

Ryan L: So Patrick and Ryan, how's this going so far?

Ryan: Terrible, this is the probably the worst recording we've probably ever had.

Ryan L: Excellent.

Patrick: That is not true Episode 13...

Ryan: The cursed episode.

(Disconnected sound)

End of episode