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Topic: Antibiotic Resistance

Bac-teria Future

It's 1925. The time of flapper dresses, jazz and Charleston dancing, elegance and glamour.

And the time where STDs are collected like Al Capone does enemies (and victims alike), and typhoid fever is a common added extra to your drinking water[1].

Except it's not 1925. It's 2035.

And you're coughing and coughing and it won't stop. And you can't breathe, your skin a fiery blaze engulfing you in waves but, at the same time, you can't stop shivering. And there's nothing anyone can do.

"Give me an antibiotic!" you'd beg today. But that's the very problem: we've not got any left; none that work anyway. And our health care is just like the 1920s was, no glamour or sophistication, and no antibiotics.

~

Okay, so we're not there yet. The only thing in our hospitals and surgeries resembling the 1920s right now, is the slightly dated décor. And maybe a few of the waiting room magazines.

So sure, we're *hopefully* not going to be faced with 1920s health care again. But that's the thing: we're only "hopefully". We need more time. Or else we will be sitting in hospital rooms, dying of infections that we shouldn't be, (probably still reading about The Kardashian's) twenty, thirty years from now[2]. But let's not worry too much, right? Because for now we still have our antibiotics, don't we?

Antibiotics. Oh, as soon as you even say the word, you feel better! They were the gift to doctors everywhere – shout out to Al' Flemming for being a shockingly grotty lab worker! Penicillin, and the other antibiotics that followed, were like the best toys doctors got for Christmas; used and used to excess until they struggled to keep up. Now the batteries are all falling out, held in with sticky tape, and needing a few hard hits to get them going.

Because antibiotic resistance happened. And, like our best toys, antibiotics are beginning to stop working[3].

See, when bacteria replicate, they're slightly narcissistic in that they make their next generation exact copies of themselves. Which is fine, but sometimes when they make these copies, a mutation[4] happens. Think X-Men: they're still the same old *E.coli* or *Salmonella*, but better. So something goes a little differently in their genes (the little nuggets of DNA that make them how they are) and that in turn changes something about them. If that change is bad, then these mutants won't survive alongside the identical cool kids that are

already there, and they'll not be around for very long. But if it is a good thing, then *they* become the cool kids that everyone wants to be like.

And antibiotic resistance *is* a good thing. For bacteria… not so much for us. They got the power card there, the blue shell in Mario Kart that blasted us out of first place.

So the X-Men bacteria with their superpower of antibiotic resistance won't normally be much of a problem since there aren't that many of them, right? Compared to all the other bacteria there that don't have the mutation, they won't be able to take over from one little mutant?

They do if we help them. And we do. We actually help the bacteria to make us sick. - *Wait, what?*

Hands up who's ever not finished a course of antibiotics? Or decided you were a doctor/pharmacist (sans appropriate qualification) and pinched some of someone else's? Or brought back an old pack you had lying around? (Don't worry, even my hand is up).

When we do this, rather than getting rid of the bugs making us ill, we select for the ones that resist the antibiotic[4-5]. So we start with the antibiotics all ready to take on the infection, in and out, mission complete. Except we're only able to get to some of the bacteria that are there. The ones with the antibiotic resistance have their shields up and can just wait it out. And the antibiotics might as well be punching a brick wall to those bacteria who just shrug and keep on replicating, making more and more of their antibiotic resistant family.

And that family of antibiotic resistant bacteria can go on and infect other people. And then what do we treat them with? And everyone that they spread the infection to as well? Another antibiotic, sure. But what happens if the bacteria evolve to resist that antibiotic too? And the next one? What happens when we run out of antibiotics to try?

And we will run out of antibiotics.

In the last 50 years, we have only managed to discover two antibiotics[6]. 2, deux, dos, TWO! And the thing with antibiotics is that we can group them based on how they work. Some like to target things on the outside of the bacteria, some can get right in there and start messing with the bacteria's metabolism so they can't make any of the things they need to survive. But antibiotics target specific things. And with bacteria evolving to resist the antibiotic, this can mean the bacteria lose or hide that target. So even if we find more antibiotics they'll most likely only be able to work or target something that they no longer have access to. And when the bouncer says you're not getting in, then you're probably not going to get in. And neither are your pals.

So we need time.

Because we *are* trying. Different ideas to keep us ahead of bacteria are under development by scientists all over the world, working tirelessly, desperately for us to have *something*. I could list a bunch here and still not have covered even a smidge of all the ideas being looked into. Bacteriocins: a protein that is made by bacteria that will specifically target, and importantly get rid of, another type of bacteria closely related to them, but not the same

strain. This really specific targeting is also good for keeping our own good bacteria that live in us happily and harmlessly (known as our microbiome) in balance. Antibodies: another protein our body makes already to get rid of infection but pre-prepared and given to us as a drug to speed along the actual "getting-rid-of" part. Enzymes: proteins made by any living cell that can be used in a lot of different ways, like to stab holes in the bacteria[7-8] or to steal essential nutrients away from the bacteria before they can get them, making them starve[9]. We have options and many, many different bacterial assassins to consider. But they're all still getting ready, still being developed and made safe for us. We're still briefing our next generation of bacterial killers while bacteria keep getting more and more resistant. It's a game of cat and mouse and, right now, we're the mice.

There are a lot of ways to go, a lot of paths for us mice to run down. But we're probably best learning from our first mistake when we used and abused antibiotics. We have options and we should use them all when we can. Bacteria are unpredictable and we need to be too. The boxer, Floyd Mayweather Jr once said, "He can hit harder and he can be stronger, but there's no fighter smarter than me." That's us: boxers stepping into a ring, sprinters on a track. Except this isn't a game; this is our lives. We don't get to try again or have a rematch. We need to be smarter than the bacteria, we need to be, not one step ahead, but three steps ahead. We have to keep on our toes and keep guessing the next move of the bacterial population so we can time our attacks well, and keep our defence up. The race is on, it has been on for years, and they're catching up on us. We can't let them. Because if we do, there's good chance that we'll be the ones knocked out for good.

It's 2016 and we still have antibiotics. *But for how long?*

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