00:00:05:07 - 00:00:06:11

Clare

Hello and welcome. I'm Clare and you're listening to Microbe Talk, the podcast by the Microbiology Society. For this episode of Microbe Talk you might want to swap your microscope for a telescope. Katherine Baxter, and I will be chatting about the exciting field of space biology, what it is, why it's worth it, and what the deal is with AMR in space.

00:00:29:13 - 00:00:44:03

Clare

Thank you very much for joining me on Microbe Talk. I'm very excited. Any time space is put in front of something, I think it makes it way more interesting. So I'm very excited about this podcast. So we start with a nice simple one. Are you able to introduce yourself?

00:00:44:05 - 00:01:16:19

Katherine Baxter

Of course. So my name is Katherine Baxter. I'm a research associate here at the University of Glasgow. I work in the plant science department and I'm currently working on bacterial pathogens of potato. But my background involves lots of human pathogens. I've worked on Candida albicans and Staph aureus Co-Cultured before, and I've also got interests. And so signaling or biomedical engineering kind of thing.

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Katherine Baxter

I've got quite a ways and varied backgrounds.

00:01:21:11 - 00:01:24:22

Clare

And so where does space microbiology come in then?

00:01:24:24 - 00:01:53:20

Katherine Baxter

So I've always had an interest in space and, and I've never really been able to put biology together with space before and during the pandemic. I came across a tweet from NASA's Gene lab, which is like the organization that owns the online data repository that has all the data from all the the following experiments, and that's open source so you can go and have a look.

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Katherine Baxter

And they had a call it for this MUSC staff course, which of course run by the Space Biology division, where you can apply. And if you're successful, you go on this six month course where you've got to speak to people who had flown for these space biology experiments and I talked to them about the logistics of how how things work in microgravity.

00:02:22:07 - 00:02:34:17

Katherine Baxter

And there was a number of microbiologists who had flown things before, and there is other microbiologists in the course. It was really good to see the possibilities.

00:02:34:17 - 00:02:35:19

Clare

Yeah.

00:02:35:21 - 00:02:58:18

Katherine Baxter

And from that I got a number of connections. I began to explore sort of the messaging lab kind of online community, and then actually reaching out to some of the microbiologists at NASA's Ames to try and collaborate on something that we can explore given pathogens. So yeah, that's how it all kind of started.

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Clare

That's great. That's so cool. So it's more just kind of like something that's just of an interest to you that you sort of pursued outside of, you know, your day to day.

00:03:08:19 - 00:03:16:20

Katherine Baxter

Yeah, Yeah. So, so it's not, it's not actually a part of my job, but I would quite like it to be.

00:03:16:22 - 00:03:29:24

Clare

So when I was researching for this podcast, I came across astronaut microbiology as well. I think the same thing. Or is there like a difference between actually microbiology and space microbiology.

00:03:30:02 - 00:04:11:22

Katherine Baxter

So space microbiology and astrobiology are seen by seem to be different things by different people. So the way that I kind of like interpret it and I know that there's some temperatures this way as well, is that space microbiology is the study of microorganisms in the space environment. So basically like gut microbiome, skin microbiome, microbiome was like the spacecraft and how the radiation and domestic gravity environment can impact the microorganisms and those microbiomes and like what kind of effect they can have on like health.

00:04:12:01 - 00:04:13:24

Clare

Okay.

00:04:14:01 - 00:04:43:14

Katherine Baxter

And also kind of like applications for microbiology and spaceflight for in-situ resource utilization, where you use microorganisms to extract things from what see like in rock. Yeah. And astrobiology is the study of extremophiles and the origins of life and how life might exist on other planets, that kind of thing. So that's astrobiology is like more that side of things.

00:04:43:14 - 00:04:47:23

Katherine Baxter

But as space microbiology is more like microbiology as we know it.

00:04:48:04 - 00:04:58:18

Clare

Yeah, like the practicalities I guess. Yeah, yeah, yeah. Like what are the fundamental differences in how microbes behave in space? Like how how do they behave differently?

00:04:58:20 - 00:05:32:02

Katherine Baxter

So vital information is different. So because you don't get it successfully on the surface and like a medium, then they tend to form aggregates. If they are attached to surface, you get this kind of like canopy structure of little mushrooms. The meat that you express, but different that there are different proteins and small molecules. So there's like a host of different behavioral changes that occur.

00:05:32:04 - 00:05:48:03

Katherine Baxter

Um, I am not too sure about epigenetic changes, but there's definitely transcriptional shifts because they have to adapt to metabolic pathways in order to compensate for what's going on around them.

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Clare

And when we're talking about them behaving in space is that like behaving in an oxygen environment like the ISI? Is that mainly zero gravity is at the main a phase, the radiation as well.

00:05:59:04 - 00:06:22:08

Katherine Baxter

So there's also elevated carbon dioxide levels. Okay, So ISIS has higher carbon dioxide levels than we're used to on Earth. So the gas ratio is different. Oh, okay. So A yes, so usually ends. I think in the Rubicon vitamins of the ISIS spots when they've stuck microorganisms outside of ISIS to see what happens when they're exposed to open space and brought them back and then they've grown halfway.

00:06:22:08 - 00:06:22:21

Katherine Baxter

So.

00:06:22:23 - 00:06:42:01

Clare

Wow, that's wild. Yeah, because it's just wild how like, life works like that, isn't it? That it's a completely different environment that they shouldn't be in or wouldn't obviously normally be in, but they still manage to kind of survive. And I suppose survive not only, but thrive, I guess.

00:06:42:03 - 00:07:31:10

Katherine Baxter

Yeah, I mean, so there's Nossa and other space agencies are really quite interesting in biofilm formation because a quiet problem in space. So there's been times when there's been instrumentation failure because there's been some kind of organism quite happily eating through wires. And there's also been issues with water supply because of biofilms in the water supply. Actually, you don't really want and where the astronauts do their exercise, like where they hang their tails up, there's also microbial growth on that panel because obviously the skin microbes have just happily colonize the wall when they're living there.

00:07:31:12 - 00:07:36:18

Katherine Baxter

It's the the ISIS isn't very clean anymore.

00:07:36:20 - 00:08:09:07

Clare

That's crazy. That's yeah, I well, yeah, that's I don't know why I just didn't think of that being a problem because it's interesting you mentioned microbiomes because I think when you initially were talking about, you know, how microbes behave in space, I don't my mind didn't automatically go towards the microbes in you and how they react. So well, it's the kind of space like state of play at the moment for our understanding of the way microbes within our body get affected by like zero gravity and sort of space travel.

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Katherine Baxter

So they do matter significantly. Yeah, there's an awful lot of rodent research studies that have been undertaken on the gut microbiome, and obviously there's astronaut studies as well. I you get a shift in the population. One of the ideas of how to support space travel and humans and space as to kind of like augment the microbiome so that you actually use it to support health.

00:08:40:02 - 00:09:01:19

Katherine Baxter

So you prevent that kind of that shift under those conditions. Or you can easily augment the population in some way so that you have lots more beneficial species that will support your health in other ways because spaceflight really, really isn't a good environment for humans or plants or on the rocks.

00:09:01:21 - 00:09:24:09

Clare

Not as cool as cool. So I always I do tend to ask this question and it can come across as quite blunt, but I would say someone might perhaps hear about the field of so space biology and kind of go, okay, so what's the point? Like, not everyone's going to space. It's not really happening right now. A cynic might say, what's the point in studying this kind of thing?

00:09:24:11 - 00:09:27:04

Clare

So what would your response to that be?

00:09:27:07 - 00:09:51:01

Katherine Baxter

A visit. We've had so much technology and understanding come down from the space program. For instance, the memory foam mattresses, they were developed by NASA. So yeah, the camera, the camera and your phone comes from developments because obviously it costs lots of money and fuel to get something into orbit. So you want to make it was as small as possible.

00:09:51:03 - 00:10:37:05

Katherine Baxter

So without space, you'd have huge cameras and your phone or no cameras and your phone and there's a lot of other technologies that people don't see that can happen. MM And the space environment is such a novel stressor for biological systems. So if you take away gravity, you may reveal redundancy that you wouldn't see normally in systems. So it's like a tool for teasing key biological questions apart also in order to what to get to the moon and almost to Mars, we're basically going to have to take as many air systems with us.

00:10:37:07 - 00:11:13:06

Katherine Baxter

And microbes are like the underlying players in all life on Earth and so they're already small and compact and just all the things that we kind of need to survive. So you take the those that technology away with you, but also you bring it back to Earth, because if you have to have closed systems in order to process waste, then you can translate that to the circular economy on earth.

00:11:13:08 - 00:11:41:16

Katherine Baxter

You can this whole idea and what sci fi is like terraforming planets. So that makes them more habitable. But and instead, if you ask, you know how microorganisms support ecosystems, then you can basically just terraform ecosystem forms have been disrupted through climate change. So microbial technologies. So this is a it's very powerful. I mean, we're faced by all this.

00:11:41:16 - 00:12:00:07

Katherine Baxter

It's climate change and rising antimicrobial resistance. That's why space is like, well, there's a whole bunch of new technology we could bring down every dead school and translate things into space microbiology. That's not woefully sorry.

00:12:00:09 - 00:12:19:24

Clare

No, that's really interesting. You hit on like a lot of things there. And one of them I obviously picked up on is is AMR, because I read something about the way that a microbe develops. Antimicrobial resistance is like accelerated in space, if I read that right, like what's the story there?

00:12:20:01 - 00:12:53:14

Katherine Baxter

So there's like, so AMR, as we know, as is basically kind of a response to an extreme stress space environment. So you have an awful lot of radiation which can increase mutation rates. In addition to the kind of elevated stress response. And so it's a bit of a kind of perfect storm of the environmental conditions that can push things towards antimicrobial resistance.

00:12:53:16 - 00:13:08:03

Clare

But interesting. So it's so even if, say, for example, I know an astronaut is in space and they're not even taking like antimicrobials, does the kind of resistance develop because of that radiation?

00:13:08:03 - 00:13:42:01

Katherine Baxter

It could I don't don't see why couldn't the track the microbiome of the ISIS and have done for several years and there are there are a number of escape pathogens up there already that they have used species that have appeared. So you've you've got this this really novel extreme in environment, because the dynamics of nutrient exchange and gas exchange are changed.

00:13:42:03 - 00:14:18:15

Katherine Baxter

You don't get convection and microgravity. So they're basically there's there's the just kind of exchange. And so you've got that kind of build up of toxins and waste products that then restaurants have to deal with. And so it's it's kind of about which multiple stressors impact this very microorganism. And then that goes towards antimicrobial resistance because you have to adapt to that environment.

00:14:18:15 - 00:14:26:15

Katherine Baxter

So you may have to increase the expression of efflux pumps in order to get toxins away that can I think.

00:14:26:17 - 00:14:37:02

Clare

You said that they've already found sort of escape pathogens in the ISIS. Is that is that like expected or is that kind of scary? What do people think about that?

00:14:37:07 - 00:15:08:16

Katherine Baxter

I mean, so we study escape pathogens and the general population. It's not they don't usually cause problems until somebody is immunocompromised or has underlying health conditions or a sort of like multiple of mutations and and spaceflight. Your immune system gets so severely compromised it doesn't work very well. You get like the emergence of like recent viruses. You deal with skin rashes, that kind of thing.

00:15:08:16 - 00:15:14:14

Katherine Baxter

Yeah, there's a whole list of like horrible things that have happened to astronauts that they don't see.

00:15:14:16 - 00:15:28:13

Clare

I would save that for next time. A kid says to me that they want to be in a well, obviously we both mentioned escape pathogens, but I realize we're not really Explain what that is. Could you explain what escape pathogens are?

00:15:28:15 - 00:16:02:01

Katherine Baxter

So escape pathogens are a group of bacterial pathogens that are associated with health care acquired infections. The escape as made up of the initial of the pathogens. So you have like enterococcus cecum, Staphylococcus aureus, klebsiella pneumoniae to the battered woman. I pseudomonas aeruginosa instrument. So that's it makes up for the escape. There's a found in the general population, but also as as the ones that caused problems and and health care acquired infections.

00:16:02:06 - 00:16:29:20

Clare

Yeah, I suppose. Is there a bigger kind of ethical question there? We're embarking on to new environments. We could potentially be bringing pathogens from terrestrial land into space. So is there an ethical question about maybe contaminating sort of new environments with our pathogens that have got antimicrobial resistance? Is that kind of a discussion? Is our topic within so a space biology?

00:16:29:22 - 00:16:46:24

Katherine Baxter

Yeah, that's a really good question. And yes, so there's a thing called planetary protection. So those two things are tied to defense, which is protecting us against asteroids and planetary protection as protecting everything else from us.

00:16:47:01 - 00:17:15:03

Katherine Baxter

And so they do these, they have like the clean the robots of going to Mars. So they're all processed in the clean room and sterilized as possible as much as possible. What's the what's the technology to try and prevent microbial contamination of whatever we're sending them to? So as I mean, that is quite a pertinent question because, like we we carry our own microbiome this wherever we go.

00:17:15:03 - 00:17:29:14

Katherine Baxter

And if it's got antimicrobial resistance bugs, then they're going where we're going. But then, I mean, that's the case with like worldwide international travel. So it's like, where do you draw the line?

00:17:29:16 - 00:17:45:14

Clare

Who would have thought that we'd be discussing whether we're going to contaminate space? And so we've talked about kind of contamination, antimicrobial resistance. And what would you say are the big sort of topics within space biology At the moment?

00:17:45:16 - 00:18:23:03

Katherine Baxter

It's data release because it costs a lot to send things into space. Everything needs to be a small and compact as possible. So it means that like you're your replicates for biological experiments, aren't as large as they could be and traditional experiments. And also not everybody has like funding access, like for instance, the funding for space biology experiments and the US and Europe is significantly more so than as in the UK.

00:18:23:05 - 00:19:03:21

Katherine Baxter

And so there's also a barrier to access to space. And so using and reusing the data that we have already as a, as a huge thing and that's why with, you know, half the open science data repository and that's where all the all the data from both ISA and Nossa and probably the Canadian Space Agency as well, and other partners are putting their data in because it means that you, you can improve access to this information to a worldwide.

00:19:03:21 - 00:19:29:14

Katherine Baxter

I mean, the space biology community is not that big and everybody vaguely knows who other people are. The the, the Frank paper of Nature recently was space omics. It's like a fantastic picture. It is a striking image associated with this, the suite of papers that came from the recent commercial mission and also with the online science data repository work.

00:19:29:16 - 00:19:57:00

Katherine Baxter

And there's there's so much information that's come out of that. Another example, there is a recent paper where looking at the root research, gut microbiome has actually shown how the gut microbiome actually impacts metabolism under microgravity conditions and bio. And so it's says these are things that would never have been discovered if it wasn't for reuse of that data.

00:19:57:00 - 00:20:07:00

Katherine Baxter

And so as a huge cause of push is to try and get some reuse of this data because it's it's kind of rare and really exciting.

00:20:07:02 - 00:20:18:10

Clare

Yeah. And I suppose the more you understand the data that you have now, you can direct experiments in future missions and things like that as to where your value is going to be.

00:20:18:12 - 00:20:30:24

Katherine Baxter

Yes. And you can also translate it to terrestrial health conditions that mimic that of what happens to astronauts in space.

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Clare

How really? What do you mean?

00:20:33:07 - 00:21:11:05

Katherine Baxter

So what, for instance, as we're seeing that the the immune system is compromised under microgravity conditions and that mimics certain immune deficiency conditions that you find on Earth. And so you get more infections caused by like your growing microbiome in space, like you would if you had that condition on earth. And so it's use as translating that can have reversible phenotype reversal space phenotype and so translating it to earth based health, health care.

00:21:11:05 - 00:21:26:08

Katherine Baxter

I mean, that's one of the things that the space biology community is trying to do is to kind of highlight, well, this is not just a benefit to space exploration as a benefit to helping people live healthy lives.

00:21:26:10 - 00:21:48:08

Clare

Yeah, because that applies. I think sometimes space travel gets a bit of a bad rep, doesn't it, for the money that goes into it and whether we should be doing it and that kind of thing. Or as if you can have real world benefits, it increases. It's kind of a sort of public appeal, I suppose. Yeah. And so you mentioned kind of this sort of reanalysis of the data show.

00:21:48:09 - 00:21:56:21

Clare

I mean, that's what you got involved in sort of after COVID, as you said. Is that something that anyone can get involved in? How does it work?

00:21:57:01 - 00:22:35:13

Katherine Baxter

Yes. So there is like an online community that you can join and they have different working groups that are based around specific topics, like, for instance, I'm in the Matrix Working Group, and there's ones that owns like female reproductive health, there's ones around AI and email, there's many of them, and they all kind of reuse the data in parallel with other data or findings and or to produce new content and new findings.

00:22:35:13 - 00:22:37:17

Katherine Baxter

And you can have breakthroughs.

00:22:37:19 - 00:22:42:12

Clare

Exciting. So I suppose if any of our membership want to get involved in something like that, there's.

00:22:42:12 - 00:23:19:06

Katherine Baxter

A fantastic project, a citizen science project that as a global citizen, science project that arose out of one of the other working groups. Speed. So it was coordinated by researchers at McGill University and Canada. And the basically they've been curating data. Is that one of the aims Life Science Data Archive holds on using that data to look at cardiovascular health and bone health under microgravity or simulated microgravity conditions.

00:23:19:08 - 00:23:47:16

Katherine Baxter

And that has had members split across the globe. And it's not just like the researchers in above women. These are like undergraduate students, high school students that are engaged with us. So it's it's not just limited to people who have spent their lives training to become researchers. It's people who have just started their journey as well. So it's it's it's a it's a it's a lovely community to be involved in.

00:23:47:18 - 00:24:06:01

Clare

I love that. And it's always like making space accessible to people, which I think is so nice. Yes. Yeah, that's a really nice story. I love that. And is there anything else that you wanted to kind of get across in this podcast or anything interesting that you wanted to share with our membership?

00:24:06:03 - 00:24:35:23

Katherine Baxter

Oh, so I just try to convey enthusiasm for space microbiology as a whole. I mean, people might not think or consider, but consider exploring that kind of avenue. But there's an awful lot of things that you can learn from growing microorganisms in the space environment that you won't be able to find out on air. So, I mean, there isn't anything on earth that replicates the space environment.

00:24:35:24 - 00:25:04:01

Katherine Baxter

It's such a unique environment. And I think there's a lot to be learned from the development of novel microbial technologies that will need to be implemented in order to achieve like more so deep space exploration. Um, I think it's actually quite an exciting time to get into it because it's just at the start and it'll be interesting to see how far it goes.

00:25:04:03 - 00:25:28:15

Katherine Baxter

Um, I'm personally hoping that when we go back to the moon, the retrieve all the, the waste that the astronauts left on the moon to see just what actually has happened to, if anything, has actually survived over this exposure on the lunar surface. I don't think so, but it would be interesting to see what what's there.

00:25:28:17 - 00:25:48:18

Clare

Yeah, that would be a finding. Wouldn't that be one hell amazing. Oh, it's been absolute pleasure to speak to you. This has been so interesting and something so different. Kind of what you usually think of when you think of microbiology. Say, it's an absolute pleasure to pick your brain. Thank you so much for coming on.

00:25:48:20 - 00:25:54:23

Katherine Baxter

Thank you very much for inviting me. I hope that these brain scans and just inside their.

00:25:55:00 - 00:25:58:12

Clare

Space is interesting!

00:25:58:14 - 00:26:18:00

Clare

Thanks again to Katherine for joining me on this episode of Microbe Talk. If you'd like to get involved in the work that Katherine mentioned on the podcast, you can do so by following the links in the description.

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