Ask A Biologist Vol 104 (Guest: Mallika Sarma)

Living in Extreme Worlds

The idea of humans traveling to the moon and Mars to live has captured our imagination. But beyond the idea of going where no one has gone before, these places are hostile and extreme environments for the human body. Planning for long space travel and life on other worlds will require more than solving some challenging engineering problems. It will require humans to think more about how we can survive in these conditions. Dr. Biology spends some time with Mallika Sarma an anthropologist who is exploring how humans cope in extreme environments and gives us an idea of what it will take for us to make other worlds our home.

Transcript

Dr. Biology:

This is Ask A Biologist, a program about the living world and I'm Dr. Biology. Let me first say that we're a bit late with this podcast. The current COVID climate has us changing our routine much the same way many of you have had to change and adjust your own routines. We're also following health and safety protocols. So we're using Zoom for our conversation today. Now with that said, let's dive into the world of extremes or what it might be like to live on an extreme world.

My guest is Malika Sarma, an anthropologist who specializes in human biology and is, currently a postdoctoral fellow in the Human Space Flight Lab at Johns Hopkins School of Medicine. Her research revolves around humans in extreme environments. These environments can be here on Earth or during long space travel and living on other planets. You might already have an idea of some of the challenges that humans will face with long space missions, but you might've missed the part about space, radiation or gravity. And if we can just get along with each other in a small space for long periods. It's knowing what to expect and how to prepare for travel to distant planets that has my guest and other scientists exploring how humans deal with extreme environments. Welcome to Ask A Biologist Malika.

Mallika:

Thank you so much. I'm so excited to be here.

Dr. Biology:

As a recent graduate. I'm always curious. Was it what you thought it was going to be like?

Mallika:

That's a great question. So, I had the great privilege of defending my dissertation and becoming a doctor in the middle of a global pandemic. So, my friends and family like to call me the plague doctor because I became a doctor in the middle of this global plague. It was really interesting. It made it very clear what parts of science were robust and what parts of science could handle a lot of stress and pressure and what parts really couldn't. It was especially interesting for me as someone who studies human relationships and how humans work together as a group to do incredible extraordinary things, to do all of this in the middle of a pandemic where you had to get really creative to be able to do just the most basic things. So, for example, when I did my dissertation defense, and so that's the public presentation that you give to prove that, you know what you're doing, and you can become a doctor. I had to do the entire thing online on Zoom as we're online on Zoom right now. And so coordinating that, talking to people, making sure that schedules across time zones work. It was really interesting.

It was also really interesting because if you take my research interests, which is how humans going to survive in extreme environments, how are they going to survive in space? Those questions become really relevant. You have to coordinate not just with people across different time zones, but potentially different planets eventually. So, it has been a really interesting experience overall.

Dr. Biology:

Well, before we jump into your research, let's talk about what we mean by extreme environments, especially those that are here on Earth.

Mallika:

Yes. So, depending on what area of interest that you're in your idea of what an extreme environment is going to change. So, if you're someone who studies extremophiles, then maybe your idea of an extreme environment is going to be a deep-sea vent because I study humans. That's not really an option for me because humans do not successfully live deep undersea next to vents unless they have lots and lots of equipment on. So, when I'm talking about an extreme environment, I'm specifically looking at where humans are able to survive. Now, because humans are such an incredible species and have the gift of technology and can wear different outfits, whether that's a spacesuit or a wetsuit or carry things with them, like oxygen, their scope of what an extreme environment changes pretty dramatically. If you just think of a human by itself, humans have been able to survive in some of the most extreme in hospitable spaces on earth.

Mallika:

So you think about the Himalayas, up in the mountains, 10,000 feet and higher. You have whole villages that have been living there for centuries and are doing quite well. Same thing with living in deserts or extreme, uh, like jungle spaces that have high loads of parasites. Things that are trying to eat you all the time, but humans are able to survive in it. And that's part of the reason I became really interested in this because I want to know how humans are able to survive in spaces where they really shouldn't. That's something that's really special.

Dr. Biology:

You mentioned while getting your doctorate, that you had to do this during a pandemic.

Mallika:

Yes.

Dr. Biology:

And while not as extreme as space travel or living on a planet like Mars, the current COVID pandemic has altered the way we live on a global scale.

Mallika:

Yes.

Dr. Biology:

Are there insights into human behavior and physiology that we're learning from this current environment?

Mallika:

Oh, that is such a fantastic question. And it's actually something that I'm currently working on right now. It is interestingly opportune to be someone that studies, how humans are able to

survive in an extreme environment. And then in a snap having the entire human population dropped into this moment. So, NASA actually has just come out with a paper, talking about COVID as a really great example of what it's like to live in extreme isolation. And so one thing that astronauts have to deal with on a regular basis, being separated and being away from their friends and family, being with a small group of people and depending on them, only similar to what we consider our quarantine bubble and having to live their lives and do really hard tasks and try not to die from space, all of these things while, being away from everyone else and that's really, really hard.

Mallika:

And so, all of the things that are happening right now, not being able to see extended friends and family Thanksgiving, Christmas time is coming up. A lot of folks are not going to be able to travel because it's just not safe to do so. Having to wear protective equipment to go outside really similar to when an astronaut goes out into space and has to do an extra vehicular activity, an E.V.A., has to wear a big suit. Luckily, we don't have to wear a whole helmet, but we still have to make sure that we have our protective equipment on because it helps save our life. So, there are a lot of similarities in how humans survive in an extreme environment like space and how they're surviving here in COVID. I think one of the things that is really, really special and I think is really coming out.

Mallika:

As you know, we are all experiencing this pandemic is the creativity that humans have is something that is really spectacular. And so, as someone who is a human biologist, my focus is largely on what is happening physiologically, what is happening to your body? What is happening to your brain, but humans are more than just your body in your brain, but humans are also the interactions that we have with each other and the interactions that we have with each other impacts our behavior. It impacts our brain and it even impacts how our body functions. They're really great anecdotal studies and even scientific studies that show that people that have greater social support, if they're able to have more people that they can depend on, stronger bonds with people that they can support and get support from, they actually are healthier people. Their immune systems function better, their cardiovascular system. So, their hearts are doing a lot better. They're not having as much disease risk. If you think about yourself and you think about the times that you felt the worst, you feel so alone and isolated, you feel the somatic, the body parts of that as well. Like your body aches, your head hurts. You just want to be in bed all the time. But if you're surrounded by people who love you, you're surrounded by relationships. People that want to get you out of bed in the morning, you yourself feel better as well.

Dr. Biology:

With that said, do we know anything we can do besides video conferencing? Have we found out anything that is helpful for those of us that you know, like most of the world? Yeah. Well, we're locked up.

Mallika:

I think the thing that is important is that human connection, no matter how you have, it is something that is really critical and can really help you as an individual survive and thrive in these really difficult environments. And so, it doesn't matter if it's FaceTime or Zoom or writing a letter to someone, or even forming a community through Reddit or TikToK videos. The point is being connected to other individuals in some ways. So some of the things that folks are exploring, not just actually in the space light setting, but in other settings where people might feel really isolated, like an old folks home, for example, um, they're exploring using AI and using robots to have robot friends. You might not be able to have a real human connection, but if you can simulate a human connection that actually helps psychologically and those

downstream psychological effects, make sure that your body is functioning well as well.

Mallika:

So if that AI machine is your friend robot, I might be dating myself here, but like in meet the Jetsons, there was the robot Rosie who was like part of the family, even though she was the family robot, or if it's going to be an AI machine that has the face of your best friend or the face of your mom. So, you can talk to this AI machine, even though if your best friend or mom is not actually there. Those are all potential options to kind of simulate this human connection that we as humans have been evolved to depend on to be able to survive in these environments.

Dr. Biology:

That's right. And we were getting personal assistants more and more embedded in our technology. So, whether it's Alexa or Siri or other things, those are really quite powerful. And in senior citizen homes, one of the things with those is they're your buddy to remind you to take your medicine, you know, things like that would work well.

Mallika:

Exactly.

Dr. Biology:

Well, right now we're doing a podcast. And one of the neat things about doing a podcast or a radio show is we have an unlimited budget for our imagination. So can you take us to an extreme environment on a potential planet.

Mallika:

Okay.

Dr. Biology:

... we might travel to and live on?

Mallika:

Okay. We are going to go to the year 20, uh, 95. And so at this point in time, we have established a Martian habitat and we have about a hundred, hundred and 50 people that are living there. Full-time living, working, doing experiments, collecting soil data, and you have come to be a scientist and explore and to witness what life is like on Mars. We'll start on earth. We'll do the whole trip. You say goodbye to your friends and family. You're not going to be able to see them for at least three years. The trip there is about a year and a half, and you're going to have to go onto the surface and do some science and then make your way back. So it's going to be quite some time before you see your friends and family again. You get the most of smelling the fresh air, smelling flowers, hearing birds in the air, giving your puppy or your cat, a big hug because you're not going to be able to see them.

Mallika:

And you're not going to be really seeing any animals of that kind. When you're on your trip, you get into the spaceship at that point, hopefully it'll be something like a plane where you will be with multiple passengers. You will probably know some of the passengers, but you're not going to know them very well because you all have trained together. But on this journey out there, you're going to get to know all of those passengers really, really well. You're going to have to depend on each other through the trip to make sure that your vehicle stays working, that you're able to share rations. If anything goes wrong, you'll have to work together to problem solve, to make sure that it all works out. If anyone gets sick, you'll have to be able to report it

immediately. So the doctor on the ship can take care of it, make sure that there are no contagious issues that will happen.

Mallika:

Fingers crossed everyone who might be contagious will be screened out, but these are all things that you have to pay attention to. Now, we're going to fast forward, fast forward to a year and a half. We have reached Mars, land, so you will feel that shift in gravity. You've gone from an earth gravity to weightlessness, to now being on Mars, which is a completely different gravitational field. And when you get on the ground, you almost feel like you're on earth, but not quite Mars is a smaller planet than earth. So the gravity is less. So you're able to do some pretty awesome jumps. You feel like you could be like Michael Jordan or Kobe Bryant or something. You can jump up, but you also have to be really careful because you're in your Eva suit. You can't have any tears or holes in it because that could be extremely dangerous.

Mallika:

And you're here to do a science mission. Whether that means you're going off into the Martian typography to go explore what the topography is like, or you're going to see how human bodies are functioning on Mars. And so, you're going to work with the people that are already living on Mars to see what is happening to their bodies. Now, people have been living there for like 40 years. So, you can see what's happening over a long stretch of time, but it's going to be a very strange experience. Anytime you're outside of a habitat, you're going to be inside your own vehicular helmet. And you're going to have, you know, a full suit on you're going to have to depend on oxygen and making sure that all of the valves and everything is correct to make sure that your temperature controlled, you're going to be extremely careful about the terrain that you're walking on.

Mallika:

Because like we talked about before the gravity is going to be very interesting when you experience it, it will be difficult to maneuver around, especially after spending a year and a half with no gravity at all. So, you'll walk very slowly. Finally, you'll get to your habitat with all of your friends that you have been hanging out with for a year and a half. And now there's a whole new group of people that you're going to have to get along with and depend on because you are all of what is humanity on this brand new planet. And you all have to depend on each other to make sure that you survive and live.

Dr. Biology:

I know there are a lot of people that raised their hand and said, yeah, I'm ready to go to Mars. I'm not quite sold on it yet.

Mallika:

[Laughter]

Dr. Biology:

I am really curious. And part of the reason I'm curious about this is I don't know that we know enough at this point to really understand if we can do that. If a human being can survive in that environment. So, let's talk a little bit about your research and how it ties into travel and living on other planets.

Mallika:

So, the way that I look at how a human functions, I look at different parts, I look at what's happening to their bodies, but I'm also looking at how they're behaving. Now, looking at what's happening to their bodies is actually pretty easy compared to how they're actually behaving. To

look at that I collect little bits of humans. So sometimes that means saliva samples. I have people spit into tubes, and then I freeze the samples and take it back to the lab. Other times I have people give me their toenails and fingernails, because you can look at some biological factors looking at the composition of what's in your nail.

Dr. Biology:

Wait a minute. So, you get their toenails and fingernails, you mean clippings?

Mallika:

Yes, yes, yes. Clippings of their toenails and fingernails, not their whole nail. That would be very painful. [laughter]

Dr. Biology:

I just, wasn't gonna volunteer for that. Okay. So, we have clippings of the toenails and then the saliva you're collecting. What can you learn from the saliva?

Mallika:

So, saliva is actually a pretty magical part of, uh, something that a human produces, because there's a lot of information that you can get in saliva. So, one thing that I look at is how stressed out someone is. Knowing how stressed out someone is, can tell you a lot about what's happening in their day, what's happening in their life, but it's something you can get from just, you know, a little tube of saliva. Another thing you can get is how active they are. So, if you're looking at something like adrenaline, you can also get that in saliva as well. So, you can get a lot of things of how a body is responding to an environment through just a tiny tube of saliva, which is pumping. That is pretty cool.

Dr. Biology:

So, then you also mentioned behavior. So, I'm assuming that you have some mechanisms to track their, their feelings and how they're behaving with others. How do you do the behavior?

Mallika:

So the behavior, I look at behavior in a couple of ways. One thing to look at what their physical activity levels are, how active they are. I have my participants were, uh, monitors. They're like fancy Fitbits. It'll tell you how active they are, how intensely active they are. Or if they're just sitting around all day and lounging and watching Netflix, I can get a good idea of that from these monitors. So that is one thing of behavior. Another way of collecting behavior is by following them around and tracking what they're doing, who they're talking to, what locations they're in, how much time they're spending at those locations. So individual A are they hanging out with their best friend all day and just sitting around some trees and drinking some Coke or individual B is going to the market and then going to the river and then going to the fields to go garden and then going, climbing some trees and collecting fruits.

Mallika:

So the, what are the different activities they're doing, who they're doing them with, where they're doing them are all important things to get an idea of what is happening with their behavior, and then to ask for their feelings and how they're feeling about things. There are a couple of ways to do that. One is we can have them fill out a very basic questionnaire or survey where they have to answer questions. Another way of doing it. It's just hanging out and talking with them. You can sit down with them, ask them about how their day was and you take notes down and then you can go back and be like, Oh, this person felt really sad. And did all of these different behaviors while they were feeling sad. We can look at these relationships and compare it, how stressed out they are and look at all of these different things together. And so

that's what I get to do is look at all of the different ways that humans are and combine them together.

Dr. Biology:

So, this gets us back to our space exploration.

Mallika:

Yes,

Dr. Biology:

Our bodies are built for gravity. And in particular, even this specific gravity.

Mallika:

Yes.

Dr. Biology:

What happens when you don't have gravity? What happens to our body?

Mallika:

So, our bodies, we have evolved, like you said, we have evolved to live in one G earth gravity. If we were to spend an extended period of time. So like astronauts spending an extended period of time outside of one G gravity, our body is not happy. And the reason why it's not happy is that it doesn't have those forces that are pulling down on your body. And so, I mean, body's very, it's very smart. It's like, if I'm not using this, I don't need it anymore. But that becomes an issue when the thing you're not using are your bones and your muscles. And so what happens in the early ages of space light before solutions were introduced, astronauts would go into space and they would come back and their bones would be so much thinner. Their muscles would have deteriorated. And the reason is because gravity does a lot of work for you. So, every day when you get up out of bed and you walk around, you're actually doing quite a bit of exercise because gravity is the exercise. If you don't have any gravity, you can just float around. You don't really have to try very hard to move. You can just go to one location to the other without using a lot of force. And so, when you don't have that regular force, your body's like, I don't really need muscles or bones anymore. And that becomes a real issue.

Dr. Biology:

Well, and that's muscles and bones, but what about your blood and other fluids that have to flow? They have a challenge just as well.

Mallika:

Yes, exactly. So, imagine you're standing in a room and you can feel gravity pulling down on you. Your bones are keeping you upright. Your muscles are keeping you upright. But if you think about how blood circulates in your body, you have a heart that is pumping and it is pumping the blood and going down to your legs is really not that hard because you have gravity to assist you. Getting back up into your head is actually pretty hard because you have to go up against gravity. So, there is more effort to get blood up in fluids, up into your head area, less effort to get into your legs. So, I would recommend if anyone is listening to this podcast and is also by a computer to look up what the puffy head syndrome that you'll see in astronauts. Many astronauts what'll happen they'll go into space.

Mallika:

And now you don't have gravity that's pulling blood down to your toes and it's not pulling all of

the fluids down to the bottom of your body, but your body is still pumping. Lots of fluid up to your head. And so, your head kind of becomes like a balloon. So, your blood is no longer being pulled down to your toes, but your body is still pumping up all of that blood into your face and into your head. And it can look kind of silly, but it actually has some serious problems that are associated with it. There are changes to your brain because the fluid is potentially pushing the brain up. This is a hot area of debate. People are still trying to figure out what exactly is causing it. Is it the fluid shifts? Is it something else that's happening? But your brain is like hitting up against the gaps that it's not supposed to be hitting.

Mallika:

Your eyeballs are also getting squished. I wish I had video of this, but you can look this up on YouTube. It's very, very cool. So, they have like a simulated eyeball, and then you see the fluid. So, this fluid normally be down in your toes, or at least not pushed up into your head. And because it is your eyeballs are getting squished from the force of the pressure from the fluid. So, you do have kind of like a red face balloon head, but it could cause some serious issues. And so that's another thing that, scientists that are looking at these questions are trying to solve because, you know, they want to keep people healthy that are in space,

Dr. Biology:

Right? So, it gets back to the idea and something you mentioned about the engineers. Engineering, whiile I'm impressed with all the engineering feats of getting spaceships and people into space. That's actually probably the easier part right now. The harder part is these things we're talking about. And so, it's curious to me, there's no way for us to go to Mars right now, even if we had the vehicle to take us to Mars.

Mallika:

I think that yes, as a biologist, I think that we are much closer on the engineering side to be able to get to Mars. It's, you know, a question of how much fuel do you need? How much space do you need? Because we're sending humans. Do we have enough water? Like the weight of the water, the weight of the oxygen, weight of food, all of that stuff, but it's math, it's solvable. It's something we can figure out. The big unknown questions are what is going to happen to a human? What is going to happen to a group of humans? How do we keep people alive? How do we keep people healthy? We also like, don't want to send people to Mars and then have them come back. And they're like barely functioning. We need them to go to Mars and do science and then come back and we want it to be, you know, it doesn't have to be a cruise.

Mallika:

It's not a pleasure cruise or a joy ride, but we don't want them to be miserable the whole time, because then they can't do good work if they're miserable the whole time. So those are all questions that we're actively asking. I think that when it comes to spaceflight, we'll probably get as close as we can get, make sure that everyone is alive and make sure that everyone is safe. But I don't think that everything will be solved. I think it'll be an act in progress. We will be solving things as they come up. And I think that's just kind of how most human science and human exploration happens. When you think about the great Antarctic or Arctic explorations, there was so much that people did not know about how the human body was going to function in extreme, cold and extreme isolation and not being able to see the sun, but people still did it. It still happened. And so I think that it's going to be a similar story with space flight.

Dr. Biology:

Okay. Some food for thought for future space explorers. Now Malika, before my scientists ever get to leave, I always ask them three questions. Are you ready?

Mallika:

I'm ready.

Dr. Biology:

When did you first know you wanted to be a scientist?

Mallika:

I first knew that I wanted to be a scientist. I think when I was five or six years old, but I wanted to be like an old school, natural philosopher that did not just science, but also philosophy and a little bit of alchemy and magic. And also humanities. I read a lot of old timey fantasy novels. And so, I was like, I want that job, even though it was not a real job. So, the closest I got was to being a scientist.

Dr. Biology:

Yeah. A cross between Jules Verne and Jacques Cousteau.

Mallika:

Yes. Basically, kind of like a Madame Curie meets Jane Goodall.

Dr. Biology:

Yeah. Yeah. Yeah. I like that. So now I'm going to take it all away from you, even though you just got your doctorate, you don't get to be a scientist.

Mallika:

Okay.

Dr. Biology:

What would you do or what would you be if you could do anything or be anyone?

Mallika:

That is not a scientist?

Dr. Biology:

Correct.

Dr. Biology:

Okay. For a long time, I wanted to be a fashion editor because I love fashion and couture, but I also love like tracking people's change through time. But I think that actually most recently, and this has emerged after doing field work. I lived in Wyoming for a year cause I was working out in the mountains, looking at people on expeditions. I think that if I was not a scientist, I would live on a horse ranch and own a little bookstore that was in the middle of nowhere, like actually like in the mountains. And so, when people are like driving to Yellowstone, they'd like to see my little bookstore and they'd stop in and then I'd become friends with them. That would be my job if I was not a scientist.

Mallika:

Okay. So you weren't a marketing major that's for sure.

Mallika:

No.

Dr. Biology:

All right. So the last question, what advice would you have for a young scientist or perhaps someone who's always wanted to go into science as a career?

Mallika:

My advice would be to keep doing it no matter how insecure or dumb you might feel. For a long time I always thought that to be a scientist, you have to be really, really smart. Only super smart people, geniuses get to be scientists. Turns out to be a scientist, you actually just have to be really curious. You just want to have to, to want to know things. You want to ask questions. And that's the thing that becomes the most important. The second thing I would recommend is take as many math classes as you can, because even if math is frustrating, it's much easier to take math classes when you're young than it is to try and go back to them when you're older. So that would be my second piece of advice.

Dr. Biology:

I like it. Curiosity and more math classes when you're younger. With that Mallika, I want to thank you again for joining me on Ask A Biologist.

Mallika:

Of course, it was so amazing being here. It was great talking to you.

Dr. Biology:

You've been listening to Ask A Biologist and my guest has been Malika Sarma, an anthropologist who specializes in human biology. Who is currently a postdoc fellow in the Human Space Flight Lab at Johns Hopkins School of Medicine. If you'd like to learn more about human physiology in space, check out our story on Ask A Biologist called Spaced Out Physiology. The Ask A Biologist podcast is usually produced on the campus of Arizona state university and is recorded in the Grass Roots Studio, housed in the School of Life Sciences, which is an academic unit of The College of Liberal Arts and Sciences. And as always remember, even though our program is not broadcast live, you can still send us your questions about biology using our companion website. The address is askabiologist.asu.edu. Or you can just Google the words, Ask A Biologist. I'm Dr. Biology.