Announcer: Bulletproof radio. A stage of high performance.

Dave: You're listening to Bulletproof radio with Dave Asprey. Today's cool fact of the day is that scientists discovered a new human organ and it could be the biggest human organ, at least that's what a team of doctors from NYU's lingo and school of medicine found. They call it the interstitium. They discovered it using probe-based confocal laser endomicroscopy, which is a revolutionary new form of microscopy. What's cool is they were able to look in living tissue instead of dead tissue and they figured out there are these fluid filled channels all over your body and it's a passageway for lymphatic fluid and other fluids. This discovery probably helps to explain the effectiveness of eastern medicine or traditional Chinese medicine and probably how cancer metastasized at least one of the pathways. This new organ if it is such a thing, lines layers beneath your skin, digestive tract, lungs, urinary system and muscles. Scientists aren't officially classifying it as an organ because there needs to be consensus and for scientists to get consensus, it usually takes three generations of dead scientists before they all agree. At which point, it just becomes obvious, at least that's been my experience.

Dave: Since I want to be around for three generations to watch the scientists die who don't do anti aging like I am, well, hey, that's okay. I'd rather watch them live but hey, that's just me. Anyway, I think that this new discovery is going to help us have a better understanding of eastern and western medicine, how they work together. Speaking of that, as of 2015, 60% of the people on the planet like you and me use a form of Eastern medicine or TCM like acupuncture, moxibustion, herbal medicine, [inaudible 00:01:49], dietary therapy, Tai Chi, Qi Gong and yoga, according to recent studies. Given that 20 years ago, all these were mumbo jumbo BS that had no scientific backing except that well, they kind of worked clinically. Now we're figuring out there really is some cool stuff going on, doesn't mean all of it works and doesn't mean when and where and why and how it works, but that's what science is for.

Dave: All right. Enough about that because I'm super excited about today's guest. Today's guest is Dr. Divya Chander who's a physician, a neuroscientist and a futurist who studied at a few places like Harvard, UCSD, UCSF and the Salk Institute and she's laughing at the way I pronounced that. I can say that because I went to Wharton, and we have to make fun of HBS, it just kind of how it works. She is also currently the faculty chair in neuroscience and medicine at Singularity University. If you've heard my interviews with my dear friend Peter Diamandis, talking about the future and about abundance and things like that, he is the founder of Singularity and I am also an adjunct faculty member there, all of that means I've only given a couple lectures over the last while, but Singularity University has changed a lot of entrepreneurs lives. I know, it's really a cool thing.

Dave: She's also a visiting scholar in the Stanford Department of Medicine, or at least was and served in the Stanford School of Medicine, anesthesiology department for eight years and has given a fantastic TED talk about consciousness, brain waves and we're going to talk about hacking humans, becoming robots, uploading your consciousness and whatever else, someone who can knock you out for a living would actually do. Divya. Welcome to the show.

Divya: Thank you. Hey, just to make sure everybody understands. I am the faculty chair neuroscience, but just faculty medicine. My dear friend, Daniel Kraft is the faculty chair of medicine.

Dave: I misread that. I also-

Divya: That's okay.

Dave: No, Divya. You studied no Divya, you studied optogenetic technology looking at light activated ion channels inserted in DNA to study sleeping consciousness and brains. Why did you do that?

Divya: Right now, it's really hard to selectively stimulate or silence certain kinds of neural networks and with optogenetics, you can actually do that. You can actually target your ion channels for the kinds of neurons or the kind of neural networks you want and then you can implant fiber optics into brains, turn on lights and actually turn these networks on or completely silence them and it's reversible. That was something we were never able to do in the past because we used electrodes and when you put electricity to the brain, you get this spherical electric field and it kind of stimulates everything around it so you don't really have any selective control. This was like a new thing about five to seven years ago, it became really huge and I think it's going to revolutionize neuroscience.

Dave: One of the first uses of this that I'm aware of was in rats, where they looked at the parts of the rats of male rats brains for violence and sex, and found that they lit up the same way but that if the rats had sex I think they were less violent, that there was a very interesting connection between it overlap of the parts of the brain. You know the study I'm talking about?

Divya: I know parts of it. I'm not a social neuroscience researcher but, yeah. Optogenetics has been used I think to dissect a lot of amazing neural networks and it's now one of the most common tools in use in all of our neuroscience.

Dave: Now neuroscientists are particularly click-ish, it sounds like. I'm not a social neuroscientists. I'm an anti social neuroscientist. Not really, but I'm asking that for a reason because one of the reasons that I created the biohacking community, I wanted to bring together all these disparate things. You wouldn't have anesthesiologists talking to sports trainers talking to astronauts. Oh, I forgot to mention, by the way, you're like a finalist for astronaut training right now too, right?

Divya: Okay, so in 2004, I was a finalist for astronaut selection and actually, that's where Daniel Kraft and I met. We were in the same exact room of 19 interviewed together. I am still in that, the highly selectable pool and so every time there's a new call for astronauts, they ping me and I reapply. We'll see. It doesn't happen with private space.

Dave: Nice. I love it, and I knew Anousheh Ansari has been on the show who is the first private female astronaut, which is super cool. In fact, I even just saw her this last weekend to

the XPRIZE Visioneering Summit where we're helping to figure out how to solve some of the world's biggest problems and then you gave a talk, that was awesome, that's how we connect the dots.

Divya: Yeah. We should open space up for everyone, that's just [inaudible 00:06:35]

Dave: Oh, we probably will. We're going to have to hack our own biology to do that at scale but that's later down the interview question, but the first one was neuroscientist probably have enough time talking to other neuroscientist and other neuroscientist's fields much less the anti aging crowd looking at stem cells much less all these other acupuncture experts and things like that. What are you doing, given that you are pretty cross platform, what do you do to look at consciousness and to bring together all these social neuroscientist, the other parts of neuroscience that probably don't get integrated into the whole?

Divya: That's actually an interesting question. One of the ways that we study consciousness is by asking ourselves, what kinds of brains are actually less conscious and we start talking to other neuroscientist to bring them all together and then we look across all those brains to see what they have in common.

Dave: Couldn't you just study politicians and just go to get sample size? I thought that was a nonpartisan comment, just to be clear.

Divya: Yeah, of course, it's nonpartisan. If they would let us, we could throw some electrodes on their brain, but we can actually image their emotions based on their facial expressions and that alone would tell us a lot but going back to the consciousness thing. As an anesthesiologist, I give people a bunch of drugs and those drugs actually remove their consciousness and they depress the brains so much that the state of being anesthetized is closer to being in a coma than it is to being asleep. That being said, we collaborate with sleep neuroscientist and sleep neurologist and coma neuroscientist and neurologists, and we look to see what all of those brains have in common and that's where we get sort of this cross disciplinary look at human consciousness. Do you want me to tell you what those things are?

Dave: I do want to know and I want to know how you're incorporating all these other fields because consciousness is a very broad thing. Like, well, I'm this type of neuroscientist. I'm looking at consciousness, did you notice those other people looking at it because I'm a little concerned that we get these tiny little tunnel vision views on consciousness that are very bound by the edges of a field and you're looking at a very big thing so I'm curious, in your state of consciousness, how do you bring in stuff that isn't specific to your segment of neuroscience?

Divya: It's an interesting question and it depends on whether you're doing experimental science or if you are considering the question on a lot larger level. When you do experimental science, you have to some extent control for certain things so you can't just bring in everything as a thought experiment because, well, yeah, you just wouldn't be able to control variables so you wouldn't be able to say, hey, this leads to that, but

you can do controlled experiments and then you can extrapolate out to sort of this larger world. You can imagine and dream up new ways of testing things so in the, let's talk specifically what I do. I actually put electrodes on people's heads.

Dave: Me too.

Divya: When I'm manipulating their level of consciousness and then I look to see what those brainwaves tell us about people's brains and which neural networks I'm turning on and off, and how different drugs that we give tweak those networks and then you can look at some other interesting questions like, are parts of the brain connected or disconnected? How are they calculating information? Is there some like causality and linkages and time and space between different parts of the brain that are broken or reestablished? When you want to bring that out to the larger picture, you need to then start to say, what does it actually mean to be conscious? The reason I like the studies that I do is because it allows you to manipulate the level of consciousness without having to first in advance, commit to some sort of philosophical definition of what it is. Everybody agrees that a person who's brain dead is not conscious anymore.

Divya: People agree that when I give you a drug to make your consciousness depressed, you don't actually feel surgeons cutting into you. You're not listening to conversations in a room. You're not speaking any longer and so I can use these really, really basic things that we know about brains to look across frames. Then once we begin to understand what those things are in common, we can start to incorporate some of these other questions like what is meditation do? Does it make you less conscious or super conscious? What do things like ecstatic states do? What are flow states? What other kinds of drugs do when they alter consciousness? It gives you sort of a framework on which to hang all these different pieces and that's where you can begin to go cross platform.

Dave: About 22 years ago or so, somewhere around there, I did my first EEG neurofeedback session and I've had one to 10 EEG machines at home ever since then and at a certain point, I realized that doing brain surgery on myself might not be a good idea so I actually have a small neuroscience institute that does executive brain training in Seattle, and that stuff has radically changed my life. I'm totally with you there, but when you talk about someone who's more conscious versus less conscious but you haven't defined consciousness, what's our scale, because I'm looking for like guru level people who's like can get their brain waves and say, make my brain wave more like theirs. Take the people come through my program, let's look at what a sample size of flow states look like and let's make it a programmable state. Not that we program it, but we show your brain how you turn it on. How do you know for someone who's 80% conscious versus fully enlightened, if that's such a thing, versus 50% conscious? Is there a scale you use?

Divya: Yeah, but we don't use it on the level of enlightenment because enlightenment is actually a pretty.

Dave: It's not defined.

Divya: Yeah, it's pretty hard to define and there are people who are more enlightened on different axes than other people. You can be more enlightened in terms of empathy but maybe not in terms of actually being able to control your own and our emotions so there's different axes even within in that world. I think it's worth mentioning now how neuroscientists have begun to define consciousness because then we can start to fill in some of these different things. Imagine that consciousness is not a single thing and let's create a two axis system. The person who first started talking about this is a researcher named Steve Laureys. He's from Belgium and he's a coma neuroscientist. The way he describes it is, well, you can either look on an axis, let's call it if people are imagining in the podcast, there's an X axis so that's the flat one. That's the horizontal line and let's call that the level of consciousness. Then let's look at the Y axis and there we're going to talk about the content of consciousness.

Divya: These are the kinds of things that you think about when you're saying, oh, somebody is solving a complex math problem or someone is dreaming or someone has actually gone into a state where they're driving and they have no idea how they got from one place to another. That axis contains all that information. What you can do is you can take all these different states of consciousness and plot them in this two dimensional space and most of the states you think about will fall on this diagonal line. Being awake and aware, you've got a high level of consciousness but you also have a lot of content there. When you're brain dead, you're way, way down at the other end. You're kind of at the origin where the two axes first meet. Most things fall along that diagonals so when you begin to fall asleep and get drowsy, you shift down a little bit on both axes and then when you really fall asleep into deep slow wave sleep, you fall further. When you're anesthetized, you go even further down. When you're comatose, you're somewhere close to that brain dead point.

Divya: Then there is these interesting states and they don't fall on this diagonal any longer. Imagine something like the dream state. In the dream state, your level of consciousness is pretty depressed but the content is really, really high and if you actually measure electrical activity in the brain, a dreaming brain looks a lot like an awake brain. It has that kind of electrical activity. What we haven't done in that two access system yet is put someone who's, let's call them an elite meditator who's been meditating for a long time to see where both the content and level of consciousness are and how they compare to other kinds of states. I predict actually while the content may go down, the level may go up if that makes sense and so that kind of a state would also fall off a normal diagonal in this two access system.

Dave: We could go pretty deep on that. I mean it depends on the school of meditation, but I've had the great fortune to scan the brains of some very high level guru people, adored by hundreds of thousands to millions of people, people who spent 30 plus years in advance practices and things and we certainly can look at differences in alpha and theta order delta and all these things, gamma brain waves that are high in Zen monks, for instance. Most of those within a few days with the right feedback, you can train the brain to at least have rudimentary controls on some of those, but someone who has experienced meditating usually, it's like, look, if you've skateboarded, you can probably learn to ride a bike better but someone who does that can get more control. There's a huge lack of

science around that definition of consciousness and what are the benefits of this state versus another state, which gets beyond your two axis system.

Dave: It feels to me like we've got Elon Musk out there saying, I would do neural lace, which to me is like the worst idea I've ever heard of, well, because I've studied implant materials and immune systems and biofilms but anyway, I digress. If we're going to put stuff in there, maybe we should understand what those states are in and if we can pick up from our skin before we start thinking things through the skin to walk around with, am I just being too conservative here? I mean you're a human augmentation thinker, futurist at the Singularity Institute.

Divya: I think another problem with doing that is right now, we don't have a lot of ways to get those kinds of devices and implants in the brain until we crack open the skull, and the average human being walking around is not going to be submitting their own self to like a dremel tool and so.

Dave: I would, but, actually I probably wouldn't.

Divya: No, you run a risk of infection.

Dave: That's why.

Divya: Bleeding and stroke and all sorts of other things happening in your brain. It's not just your willingness to add basically cybernetic parts to yourself. It's what's the risk and that is the most beautiful and eloquent organ you have so it's something that you don't want to undertake lightly. Recently, a group in Melbourne actually found a way to deploy brain machine interfaces by actually going through large vessels in the groin and sending up metal electrodes on a wire cage, actually through central veins and there is a vein that overlies the motor strip and so you can actually deploy an entire cylindrical electrode array that can function like a brain machine interface without having to crack open the brain at all. You don't need neurosurgery. That's kind of a cool thing and I think that's going to be something that's more likely to happen in the future. You got to imagine that, that electrode array is what, it's going to start sticking to the walls of those blood vessels. Are we ever going to go to get it out if we need to or is it going to cause this huge bleed in the brain? Not sure.

Dave: Do you worry about voltage gated calcium ion channels in cells with EMFs inside the brain affecting mitochondrial function?

Divya: Do you realize that, that's not really been tested. When we actually test, like go back to the optogenetics thing. When we insert these ion channels, one of the things we do is we actually look for temperature changes and overheating. When the initial optogenetic studies were done, they did a lot of controls and they actually looked for things like the neurons changing shape, neurons dying, neurons burning up, things like that. Mitochondrial function was never looked at, at that point.

Dave: Those who did it didn't evaluate that there's certainly not a heating effects, but there's a calcium influx that tends to happen because when you get an electrical field, that one ion gate opens up, according to a whole different people I interviewed over time, but it's not something that you would see except maybe over a long period of time if mitochondrial function goes down, you get more inflammation in the neuron. It's not going to die right away and so they're not going to burst like popcorn in the microwave, which is sort of what people like to think about.

Divya: Yeah, no, I don't. I don't see that happening if anything, a neuron would just slowly degenerate but I'd still say that the link between an EMF calcium channels and mitochondria is probably not as solid as you might think, but because you have to understand, okay, there's a thing. I should believe in delivering energy from the outside. I think that's the future.

Dave: Me too, by the way, pulsed EMF light. I've been doing the Russian sleep machine for 20 years. I'll just have all works is real. There's no question about it.

Divya: The question is how deep can it go right, because when you deliver energy from the outside, the surface of the brain is going to receive a lot more than deeper structures and so there you have to start modulating the amount of energy, the amplitude, the frequency to actually modulate structures you're really interested in and so, the actual mapping of all this stimulation isn't entirely clear to me yet. People are working on this like focused ultrasound. They used to think, couldn't get as deep as they wanted but actually we're getting ultrasound and even potentially infrared deeper into the brain than we had thought before, and you can actually manipulate neurons now using things like ultrasound sound waves.

Dave: That makes me so happy. I haven't tried ultrasound like that. I did do ketamine and the high powered direct magnetic, very focused frequencies with the psychiatrists down in San Diego, David Pfeiffer was on the show.

Divya: Did you do it simultaneously or in sequence?

Dave: I did the magnetic stuff first, and then I did the ketamine right afterwards, but not at the same time. It was mostly just a function of time and being able to get it on video for Bulletproof listeners.

Divya: Did you record your brainwaves when you did that?

Dave: Unfortunately, no. He didn't have an EEG setup and I, if I'd thought of it, I could have brought my 24 hour [inaudible 00:22:11] set up from 40 years as then, but I, that would actually have been cool. You must have seen ketamine? Ketamine is one of those like PTSD drugs.

Divya: I use ketamine all the time in the operating room so I actually have a good number of brains with an EEG that's been recorded frontally that are on ketamine and you can see, it's really interesting because you see this, basically these higher frequencies get kicked

up using ketamine and one of the problems is a lot of the algorithms that are used to try to figure out how conscious or unconscious you are, can't deal with ketamine because ketamine makes it look like the brain is waking up, but it's in fact an even deeper gravity well than it was before.

Dave: You're talking gamma or even like hundred hertz kind of things?

Divya: No, it's mostly beta activity actually.

Dave: Oh, just beta, okay.

Divya: Yeah, but what happens is when you are anesthetized, your brain looks a lot like it does in sort of deep slow wave sleep so it's got a lot of delta and then it has this sort of ultra low beta rhythm but nothing like what ketamine does.

Dave: It doesn't fit in the mold so people don't [inaudible 00:23:15]

Divya: No, no.

Dave: I believe that.

Divya: It's because it stimulates a different receptor right, so ketamine talks to something called the NMDA receptor, whereas most of our anesthetic drugs, most of the things like alcohol itself or Valium, most of the drugs we move self medicate with, manipulate something called the GABA receptor and GABA is an inhibitory receptor, what's chloride into neurons and so it kind of depresses a lot of they're firing patterns. Ketamine is really really different in terms of its target. The other drug that also targets the NMDA receptor is nitrous oxide, it's laughing gas. It does the same thing. It actually causes this really buzzy state to happen in brain.

Dave: What about the other two big fancy ones, salicide or MDMA or LSD? All of those are, they talk about those in the context of consciousness. They're all being studied now for the first time in 30 years. Are you scared of this or are you happy about this?

Divya: Oh, I'm not scared of it at all. I personally haven't measured brains like that, mostly because I don't use LSD or angel dust or any of these other psychedelics in my practice.

Dave: Not only that, I mean you're going to be going to space so you would never touch these things because that would be bad. I totally get you there.

Divya: I've actually encouraged people who are using drugs to actually do something so much what you do, which is to record these states using an EEG and there are, there must be some older studies out there with high density EEG in these different states.

Dave: Probably.

Divya: Here's the thing that makes psychedelics really valuable actually in therapeutic practices. Your brain is kind of, it's already wired in a particular way. When you learn something, you lay it down into a network and then that network is reactivated with a similar set of inputs over and over, and that's why it's really hard to quit a habit because it's metabolically expensive. You have to break pre existing connections in order to form new ones. What psychedelics do is they kind of subvert that process in as soon as you take that psychedelic. They are actually changing connections immediately within neural networks and what happens is, if you couple taking a psychedelic with other kinds of input, so let's say you have PTSD and you're in a session with a therapist and the therapist is actually able to take you on a guided journey where you relive, maybe the trigger for that PTSD memory and you do it with a psychedelic on board, you can actually lay down different responses in your neurons to the old triggering memory. This is why it's actually useful for breaking habits. It's why it's great for all kinds of therapy.

Divya: Those effects are actually mediated also in different parts of the brain, it's some of the short term effects so, but psychedelics are incredibly useful that way. I think we're finding more and more places that psychedelics are actually going to be helping people in these different spaces.

Dave: You as a futurist, have talked about this idea of human augmentation. I am philosophically in favor of human augmentation but as a computer scientist guy, I think it's kind of absurd to throw away your computer and get a new piece of hardware when you have code that's wasting 75% of the processor you have now. It feels like I don't really want to get rid of my current hardware, I'll maintain it well. I don't really want to get rid of that until I've made full use of it as it's running at full capacity and it's maxed out and I need more capacity, then it's like, okay, I want a robot arm on the back of my head or something or a USB, 132 gigs of memory kind of thing. Where do you draw the line on upgrading the human brain? What is limited to the brain versus all of humans between making what we have worked better and adding something external to your brain?

Divya: Yeah, I mean, I don't, let's push that back even further. Making what you have work better versus fixing a diseased process, right? That's actually originally where we started from.

Dave: Absolutely.

Divya: All these brain machine interfaces. I mean people like to say that they are the first cyborgs and things like that. They're actually not. It's the patients who've been having implants for a long time, let's say to combat paralysis or Alzheimer's disease, Parkinson's, that kind of thing. These kinds of people were actually the first cyborgs that we really had but what we're doing there is replacing something that's gone bad and that's not quite the same as augmentation, but it's on that same pathway. When you start adding things to yourself and everything was already functioning pretty well, that's a different step and let's look at something like working memory. It turns out you can actually non-invasively modulate the brain and improve your capacity to remember things.

Dave: That's in game changers, by the way, my new book, I can say there's a whole chapter on [inaudible 00:28:36] thank you for saying that because people still say you can't do it. We have a real neuroscientist like professor, like bad ass, who just said you can improve working memory. All right, sorry.

Divya: You can. It's not my area of research so there's, I give a shout out to all my colleagues in the world who were actually doing this kind of research but they're trying it both in old and young brains. Now just imagine you take, not an Alzheimer's patient, but just take a normal person and you deliver non-invasive neural modulation and you start to improve their memory, so far, the effect of reverts back but we may find a way to make that more permanent and once these changes become permanent, now you've created sort of a second level of human. You've created an extremely elite human right? I mean what kind of capacity have you given them when suddenly their memory is better than most of the populations. Then there's like the third kind and that is adding things that you never came with in the first place.

Dave: I want that.

Divya: I refer to that whole movement of people that are inserting RFID chips in themselves. People who are actually inserting gravitational sensors on their feet so they can sense seismic activity like earthquakes and other kinds of vibration. People that are implanting magnets so that they can tell where true north is. They're going to be like migrating birds.

Dave: I did that for six weeks. It wasn't an implant but I wore an ankle bracelet that vibrated true north. It was about eight, 10 years ago.

Divya: How did that, it was creepy.

Dave: It was after a couple weeks until the soldering broke because I didn't solder it very well. I have no sense of direction. I never have. I'm completely visual based. I started to know which way north was, which was a new sense for me and I wish I resoldered the thing before I lost it. There's something happened. I can't explain it, but it wasn't.

Divya: Yeah, no, no. You bring up the greatest point. No, no, you rewire your brain, right so that wasn't a permanent implant but it's a great idea. If you add a new sense or new organ, you actually need a new part of your brain to be devoted to receiving that information and processing it, if you use something like sensory substitution so if you're a blind person and you begin to use your sense of hearing or taste or touch to move through the world, those parts of your brain become bigger and they takeover. Let's say you implant a new organ, a new sense organ, you are now driving plasticity in those people's brains and at some point, you have to ask, are those people still human? You have asked me if there's a line, I don't actually know where that line is.

Divya: I mean, when you're correcting something that's gone bad in the diseased person, okay, maybe you might want to argue they're still human, but when you start augmenting people whether it's giving them a boost in what they already had or adding something

completely new, I think you're actually pushing evolution in a way that natural selection never, never expected, right because I mean who expected that kind of environmental pressure? Then you got to say, can you pass it on to your kids?

Dave: Oh, you probably can with training. I mean my kids get wired up to electrodes on a regular basis.

Divya: Oh, no, no. I mean like let's say we make you smarter, okay?

Dave: Like pass the genes.

Divya: Okay, let's say we start stimulating your brain. Do you modify your ethnic genome in such a way that you can give it to future generations? That's something that's also interesting because modifying your germline is a big deal, right because we've got CRISPR now. We edit genes, and that seems to be, when you talk about lines in the sand, that seems to be at least people give lip service on an international level to that's the line in the sand. You don't CRISPR people's gene, like germ lines.

Dave: It seems like BS to me. I mean, there's risk from CRISPR but my first book in 2011 was called the better baby book and it's like, hey, here's everything you could do to your baby to have a smarter baby in this generation with better genes that get handed off to your grandkids and probably seven generations down, but we know for sure three generations down, so an upgrade to your germline? Eat this before you're get pregnant, pull this stuff out of the body and do these whatever 10 things and this is what we did for my own kids. My wife was infertile when I met her. She's a trained physician, and so we restored her fertility and then we kind of went for the epigenetic switches and we threw all of them in the direction of making our grandkids healthier too. Okay, you can already do it and what's the difference if you decide to do it in a petri dish somewhere or if you just do it on your dinner plate?

Divya: Yeah so again, you bring up a good question. Where is that line?

Dave: I don't know. I'll find it.

Divya: If you start to edit genomes though, let's say you are trying to change eye color, hair color, height, physical strength, I don't know, what's to say it? It gets back to doping right in sports. You can take steroids, you can't take epogen. All that steroids and epogen do is to kick up the system that already naturally exists in your body right. Growth hormone. They kick up things like the ability for red blood cells to carry more oxygen. You're kicking up actually the natural processes, but we have decided that, that somehow tilts the playing field in favor of the athletes that dope versus the ones that don't. The only solution is all athletes don't dope or we have all of them augment themselves however they want.

Dave: As long as they tell everyone else what they're doing, they should be allowed to augment because what we also allow that seems entirely unfair, is we allow athletes to train in different ways, which isn't fair at all so all athletes should have to lay in bed

unless they're competing and all eat exactly the same number of calories per gram. Otherwise, it's not a level playing field. I mean seriously, how is this even fair? Why do the athletes who can afford the top, top trainers who have the best facilities, they get an unfair advantage, the other ones don't. This whole doping thing just pisses me off, like if you're going to do it, just tell us what you did so I can learn from it and you can learn from it and our kids can learn from it, and then we'll have much more exciting sports matches, all right. There, now I just pissed off all [inaudible 00:34:55] friends. Sorry, guys, you should all be on testosterone if you're over 35, you'll last longer and for you women, the same thing, just different doses.

Divya: You know there's other things too, in terms of drawing that line in the sand. Okay, let's say you are a woman and you have cystic fibrosis. Shouldn't we correct your germline so your children don't have it or if you have Huntington's disease, things that are autosomal dominant that you have a very high likelihood, 50% chance of passing on to your kids. You had mentioned sending, space travel, something that's near and dear to my heart. Well, what if we could actually edit genomes I'd say of future generations and make them say more radiation tolerant. Wouldn't that increase the chance for the human race to survive if we send them into space without mutating developing cancer and dying early or growing like for eyeballs.

Dave: Just having your brain shrink dramatically because your cerebral spinal fluid gets to be a little bit.

Divya: That's different. That's microgravity.

Dave: It is.

Divya: Whether or not we can, I've been thinking about that with a couple of friends, whether or not you could make some sort of gene level changes are actually just in the podium, right? The expression of the right proteins coming from, they're transcribed from your RNA to help people better combat microgravity, that stimulus seems to be a little bit harder to deal with than the radiation one.

Dave: It seems to me and tell me if I might piss you off and a lot of other people, but getting to Mars isn't that hard. Surviving the trip and surviving on Mars is really hard, so we should be spending as much money on reengineering humans to live in space and on Mars as we are spending on ships to get there. Otherwise, there's no point. Is that radical or no?

Divya: No. I think a lot of people are thinking about this. I would say that probably maybe our crops that we take with us, that's probably the first thing. In fact, we use CRISPR and agriculture's been one of like the main targets so we can feed more of the planet. If we can CRISPR organisms that will survive on Mars or on asteroids or in a station that's spinning, yeah I think we have a much better chance of survival. Everything is ethically fraught. I mean, there's going to be no way around this. We already have these technologies that make people feel like they're playing God. Well, we have them so we need to start talking about them.

Dave: I just spent a while interviewing and having dinner with Andrew Herr, who spent 10 years with the Department of Defense looking at augmented soldier programs and things like that and he said on the interview, if memory serves, that he was convinced that somewhere on the planet, some governments are doing this stuff already.

Divya: Oh yeah, they absolutely are.

Dave: Anyway, I was going to say you may have knowledge you can't talk about or you may but if they're doing it, and it's not allowed in the U.S. or Canada or somewhere else, I can tell you, if you put on your hundred year hat what's going to happen and it's not pretty, so isn't there an ethical requirement to do it if someone's doing it because otherwise, over time, we stop evolving?

Divya: In some sense, you're right and on the other hand, that's the argument that was made for nuclear proliferation. If so and so is building nuclear weapons, well, they're going to get ahead and if they're a rogue state, then the whole planet's screwed.

Dave: What happened is that the countries with nuclear weapons became the very powerful ones because they had them, so the countries with augmented populations or maybe just augmented soldiers, if you want to be all cyberpunk about it, well they're going to be the ones with all the power 100 years from now, so it seems like it could just be a nation state thing, or it could just be a fundamental human right, like it's my biology, let me upgrade it. If you get in my way, you're an enemy of humanity and I'm going to use my laser eyes to burn your legs out from under you. I'm of that camp where this is a fundamental right. If I want to stick screwdrivers in my eyes because I'm dumb, then that's my own fault, but if you try to stop human progress, you're probably not on the right side of history. Am I that radical?

Divya: No, no, I think that's probably going to be the way everything falls out, but the one thing that's really important, I think you mentioned it before is that it's going to be a fundamental human right as long as everyone has access. If it becomes this thing where only people who have money, wealth, resources or political influence basically get access-

Dave: You mean like cell phones?

Divya: Well, actually, cell phones is a really great example of democratized technology.

Dave: Exactly but if you go back to when we were young, I'm guessing you and I are about the same age. I might be a little older than you, but I can tell you when, if $40,000 for a cellphone in you're trying to earn $25 a minute and you saw someone in their Mercedes driving with it, you're like that jerk who they think they are just rich jerks and now it's not like that and I think every technology we've talked about in the show, everyone had ever talked about on Bulletproof Radio and 500 episodes, all of these are going to be available for $5 20 years from now,

Divya: I think the abundant mindset, yeah so that's going to be the case but I will say that when technology's powerful, there are people who try to at least hold on to that kind of power by making certain things exclusive and the question is for how long. The movie that always comes to mind is Gattaca. I mean, that movie's like over 30 years old, but once you create a race of genetically superior people and they have time to procreate, you can build up a large enough number of these people that they can actually control the rest of the population, and so I'm not saying that the technologies aren't going to get faster, cheaper, better, but it is worth looking out for how the technologies are being developed so we make sure that these technologies are available to everyone.

Divya: If we control the means to distribute, I mean food. For God's sake, that should be so cheap. We throw out most of our food. Why are people malnourished? Because we have like, completely screwed up distribution systems on this planet. That shouldn't be that way and that's what I want us to keep thinking about as we develop these technologies that we don't make it so that people who don't have resources can access them easily, so I guess the way of the smartphone rather than food.

Dave: Yeah, it's a great analogy and it's one of the reasons that I chose the word biohacking for what I do. The hackers are the ones who wrote open source software, like if you're buying software, you don't know what it does, that's bad. If you could just see what it does, maybe that would be better and so by identifying the technologies once we just talked about that allow you to change your brain or someone else to change your brain without your consent or awareness, if you know the technology exists and you know you could use it and maybe choose to use it, I think that is a better place than if some shadowy bad people do it.

Dave: By the way, I usually don't believe that much in shadowy bad people. I believe in emergent behavior from complex systems that looks like shadowy we bad people, but most of the billionaire types I've met and the people who have the means to do this are actually not like that. They're trying to make the world a better place. They don't know how, and it keeps breaking like our food system so I don't think Mr. Smithers is out there doing bad things.

Divya: No, no, I think, but here look, if you somehow limit the music production or access, you'll develop probably a black market, right and people sell their organs on black markets. We need to be just vigilant, whether it's an emergent property systems or there are bad actors doesn't really matter. These systems will form and what I don't want to see, and this is a very controversial topic, but what I don't want to see is people who want procedures, who go have back alley procedures like abortions and can't get access to them. We don't want to create a system that sort of incentivizes the black market or a back alley system. We want a system where everyone has safe and easy access to all of these different tools and what that's going to look like in the end, I'm not sur.

Dave: Are you hopeful? I mean, you are deep in this stuff, deeper than I am.

Divya: Yeah, I am hopeful. I've also seen a lot of technology abuse so I have this sort of side of me that just is like, you can't just sit there and be sort of wishful and hopeful and not take action.

Dave: What is technology abuse the way you're talking about it?

Divya: Again, it's this sort of idea of controlling the means of production or access because of primary or secondary gain. Let's use a different example. Let's just talk about climate change for a second. That's kind of a runaway system now, right? There are people who seem to be controlling this narrative because a very, very small group of people is going to benefit in a very, very short term by preventing the world from taking action. We could have done something 20, 30 years ago. There's a lot of data that shows that we knew that this was coming. I'd like to see people not just kind of sitting back and assuming that technology is going to develop the right way because there are enough smartphones in the hands of people in villages in Africa.

Divya: I want people to get more active and say all the technology we develop, we need to be thinking about what the implications are for their ethical development but also the democratized access to these technologies and then play a really active role so these things don't fall into the hands of a select group of people.

Dave: I absolutely support that and if it makes you feel any better, at the XPRIZE after you left, I helped to fund the creation of an XPRIZE to just suck carbon out of the air.

Divya: Yeah, awesome.

Dave: Just like vacuum that stuff up and out of it and do it with solar power. There's probably a way and if the climate deniers are right hey, it's not going to do anything. It doesn't matter then, right but I'm pretty sure that we have a carbon problem.

Divya: We have a carbon problem.

Dave: All the data I'm looking at says that.

Divya: Oh my God, as much as scientists can agree on anything, they agree on this.

Dave: That's also kind of scary and I think that we have a carbon problem. I just said it, but there's also a strong consensus that the earth did not revolve around the sun and so consensus in science is kind of scary, the calories in, calories out consensus, which was totally destructive of human health so consensus is frightening but I can tell you, this looks pretty important and whether you think man did it or volcanoes or sunshine, I mean, I don't care if we vacuum the stuff out of the air. You always can argue about whose fault it is. I don't really care. We'll just fix the problem because the problem is real.

Divya: Yeah, I'm with you. It's a real problem, but that's where you asked me about that balance between being hopeful and just kind of letting things happen and I actually

think that everybody has to take a kind of an active role in the development of our evolution and new technologies. It isn't good enough to sit around passively and say, oh, yeah, that will just happen the way it ought to.

Dave: Do you have kids?

Divya: I don't. I have eggs on ice.

Dave: Are you going to hack them before you fertilize them?

Divya: Possibly not but I would like to actually screen them before implant.

Dave: I have met a global elite, wealthy person who went through and removed all genetic issues that he was aware of from his children.

Divya: Can you share names?

Dave: I will not share names, but he told me about it. He said it had to do with genes like Huntington's or something, I don't remember what it was, but yeah, a couple of things that were pretty bad. There was a reasonable chance of his kids getting it. He said, why don't I just permanently remove that from my family? He did, and so this is happening and it kind of makes me mad that this isn't something you can do but the more eastern side of me who understands epigenetically Mother Nature, for lack of a better word, the system of your mitochondria interacting with the world decides which egg drops based on the environment you're in and if you kind of bypass that part of the system, we don't know what that does and there's some biological rationale for the selection of the egg and no one knows what it is so if you're just going to go in and freeze some eggs, and then you decide to implant one, is it the best egg for the environment? God knows.

Divya: Yeah, we don't. In fact, there's probably good data that says, well when you freeze eggs instead of embryos, you get an even lower yield, right? Eggs that are frozen that are already starting to divide do better, but we don't screen until that thing has implanted and starts to really develop into the fetus, and I think that ought to change. I think Bob Hariri might agree with me on that one. I also think that hey, banking our stem cells much earlier than we do, I mean we're going to get to the point where all children have their stem cells bank, all children born but right now, us adults, most of us don't have any cord blood to go back to or stem cells from our placenta. We ought to be really looking into that because talk about rebuilding and regenerating our organs.

Dave: My stem cells are banked, but they're 42 year old or something. I wanted my kids but I didn't want to give my kids liposuction because when you're 11 or nine, that's just mean. It hurts, so it's a really tough one like where you're going to get the stem cells, like yank a tooth that's still doing well and extracting culture. There is no pain free way to get stem cells from a kid, maybe some bone marrow when they're knocked out. I know that's all pretty invasive and risky and I don't think I'm going to do that to my kids but I'm with you. I wish I just saved their cord blood at the time. There wasn't good data

that said it was good for anything when my kids were born It was very intensive, so I'm not doing it. The reward versus cost isn't there.

Divya: Hey, you have to store it too, so remember, we're talking about democratizing access. Is everybody going to be able to afford the freezer costs?

Dave: I could agree with that. It was thousands of dollars a year and I'm like I'm the sole breadwinner in my family. That's not going to work, so I decided I'd rather buy good food.

Divya: Anyway, but you see what I'm saying, like this is the kind of thing where we have to think about the implications of these things, because technically everybody's got cord blood, but that doesn't mean that everybody can afford to bank it, so I'd like to see us thinking about how to make all this kind of technology available to everyone rather than just some select elites.

Dave: Well, we agree on that and I believe that this is one of those international treaty fundamental human right things.

Divya: Yeah, I do too.

Dave: Visibility is the first thing we need so if a country is going to be creating upgraded germ lines, no problem, you just have to say you're doing it so we all know and then we can all decide what we're going to do and we can decide to evolve ourselves more rapidly than we otherwise would or not but to have it happening in hidden pockets of wealth or secret government labs where Wolverine is coming out, that pisses me off because I seriously want those Wolverine powers. Anyway that's just me but you probably do too.

Divya: Certain kinds of powers, yeah I'd love but hey, going back to the whole thing where you were talking about meditation to begin with. There are just some really ancient things that we can do to actually completely hack ourselves and it's correlative right now but there is some data that's now showing that meditation increases telomere length. In other words, the things that protect your DNA so you can increase your longevity just by meditating. Another one is meditation is actually, again correlative. It's not causative. They haven't done that one but people who meditate, you actually see more gray matter in almost every area of the brain that they've looked, and they don't show all that age related shrinkage or atrophy in brains.

Dave: 87th percentile hippocampus size, just thought I just got to say that.

Divya: Hey, I thought you didn't know where you were in the world? You know you need your hippocampus to like, navigate, right? Maybe it's those magnets.

Dave: It's something or another but that's the other problem is if you're a biohacker, brain hacker, you're results driven and if you're a neuroscientist, you're data driven, you want the map and I want the results so I'm willing to do 10 things and if eight of them didn't work, okay, did I get the result I wanted? If so, hooray, then let's go back and let's tease

out which ones worked and which didn't, but in the meantime, I was getting old. I had cognitive issues in my 30s and I don't really want to wait around. While science figures out why, I want the results and I'm willing to share.

Divya: I get that.

Dave: It's very pragmatic but also it makes scientists mad because I want to do one variable like, sorry, it's an eight variable problem. I did 16 and I got eight of them that worked and I'm happy. Is there an answer to that? Is science going to get around that I controlled for all effects, kind of like self story we tell ourselves?

Divya: You're not going to get around it in a one, there's no way.

Dave: I don't mean in a one but like you said earlier-

Divya: There is a way that if you add all your data, it's like a growing database, right? You basically say I manipulated all these many variables, which is much more like real life, and you put as much as you can into that curated database. At some point, we might have a sufficient amount of data that algorithms can kind of come in and start to look to see what those relationships are. It's a data problem so on you, personally we may not know if you manipulate a bunch of things at once and I say this all the time, I'm just like you in the sense that as a scientist, I kind of want to know what caused what, what gave rise to what, what variable did I tweak that led to this outcome. That's not practical in real life so when I for instance get sick, I usually don't go to a doctor. I go to an acupuncturist. I sometimes breathe or meditate and push my breath into areas that are bugging me. I visualize things, and I try to get more sleep.

Divya: If I get better, do I know exactly which of those things actually helped? Probably not. Maybe they all did. Maybe only one of them did. It's kind of hard to know.

Dave: It's one of those things about being alive. The other thing is at the beginning of the show, you said something about how you're controlling for variables and studies. How many of the studies that you've performed, controlled for the phase of the moon?

Divya: None of them.

Dave: Does the phase of the moon affect brainwaves?

Divya: I don't know. I've never measured that.

Dave: It does.

Divya: You've seen studies on that?

Dave: I have, well the guys from-

Divya: Your own?

Dave: No, no, no, the Global Coherence Initiative of Rollin McCraty at HeartMath. I've been an advisor to HeartMath for a bunch of times.

Divya: I see.

Dave: He's done some pretty outdoor stuff but there are subtle changes there and in terms of effecting brain waves and brain waves are proxies for behavior, any emergency room doctor including my wife will tell you something happens on a full moon because the ER fills up on a full moon and any cop will tell you the same thing, so we kind of know brainwaves drive behavior, so I'm willing to just give that one yeah, that exists, but the other thing, in mouse studies, the outcome changes dramatically. If a woman feeds the mouse versus a man feeds the mouse, it changes what the mouse does. They don't control for that so we have this fantasy that we hold the variables.

Divya: No, you're absolutely right. Actually, you bring up a really good point. It affects reproducibility of a lot of scientific experiments. Most of them are actually not as reproducible as we'd like so if you give some of the exact same protocol, they might come up with a different result, and so unless you have multiple studies done multiple ways to kind of the same answer, sometimes it's hard to say that a produced b. It is, you're absolutely right, that's the way science is done. Circadian rhythms we do know markedly affect a lot of our outcomes and I would say that there's undoubtedly a circadian effect on my patients because in fact, when I ask them what time of day, even sleep pressured, it makes a huge difference.

Dave: That's a good point. I just got back from New York. I'm back on the west coast so I got back about two hours of our interview and I was wearing my colored glasses, my too dark glasses. This is one of the companies I started around circadian biology specifically to solve jet lag and sleep issues that's worked but everyone at XPRIZE was saying, Dave, why are you wearing those weird yellow glasses? I'm like, trust me, my brain works and I can show you EEG studies now and within 15 minutes of putting the glasses on, you see beta drop, you see alpha go up. These change your brainwaves like right then and there, and I guess what's missing from all of this huge body of research, like I said, what time of day was that and surgery outcomes.

Divya: Everything matters actually what time of day. Think also about like the quality of your sleep and if you use like a smartphone or a device before you go to bed, and all that blue light coming in is really bad for almost making your brain sync like it should be awake, so we do all sorts of weird things to alter our circadian rhythms and most of them not so good.

Dave: Now, as an astronaut wannabe, have you seen the lighting in the space station? Is that not just doubling the rate of brain decay in astronauts or what?

Divya: I don't know if it's doubling the rate of brain decay but I would say that the entire environment of the station is not well optimized at the moment for human function in general. For instance, I had another friend of mine who knows quite a lot about the space program and she was telling me there's a lot of noise, just ambient noise, the kind

of thing that if you were at home and you heard like someone's HVAC system going off, and like letting out, and then clattering and things, it would just be spontaneous to keep waking you up from sleep. Well, the station is just full of noises like this constantly, all these mechanical noises so most of the astronauts or cosmonauts, whenever they think they're supposed to be sleeping, their sleep is really, really fragmented and that is affecting human performance in space but it's probably affecting your longevity and probably contributing to possible, I don't know dementia early in life, earlier in life than perhaps they should have it.

Divya: We don't even have those longitudinal studies.

Dave: For everyone listening, if you're sitting there going, oh my God, we're so screwed, look at it this way, if you're worried about having a job, these are not the kind of jobs that we're going to automate anytime soon. There's a lot of work to be done here. I mean, a lot of work so go out and study brains and get a degree in neuroscience or psychopharmacology or something interesting like that because we're barely scratching the surface. We haven't yet upgraded our biology. We don't know how to make an environment on the surface of the earth. We can see all that we can live in and like there's just plenty of problems to solve. Just go pick one or three and just go with that.

Dave: I have one more question for you Divya, it has been a fascinating conversation. Someone comes to you tomorrow and says, based on everything you know, everything you've done, I want your three most important pieces of advice to help me perform better at everything I do as a human being, three most important pieces of advice. What are they?

Divya: Oh my God, they're stupidly simple.

Dave: Go ahead.

Divya: Is that okay?

Dave: Yeah, no I want the three most important things. If they're simple, maybe I'll do them.

Divya: Sleep eight hours a night.

Dave: Not more because you'll die more often right?

Divya: Not necessarily. If your body's asking for it, no I'm serious, if your body's asking for it, give it what it wants. Exercise, exercise, exercise and exercise, you'll give birth to new brain cells and you'll protect every organ in your body and decrease your immune inflammatory response, and meditate. Actually last thing is actually keep a gratitude journal.

Dave: It's one of my top three.

Divya: Yeah, there's a strong association between people who look around them and see all the things that they have to be grateful for in their lives and their general health, their immune function, a cognitive function and longevity.

Dave: This is why, by the way, if you're doing something meaningful online, and a science troll attacks you and a science troll is someone who just goes to PubMed, and then posts the link and says and that means you're a poopy head or whatever insulting, those people, they're shortening their telomeres, they're damaging their brains and here's what you'd be grateful for, it costs you exactly half a second to click ban, delete and they can't see what you say anymore, you never have to hear from them again, it takes like a minute to do that so you'd be grateful that people like that are pruning their neurons out of existence. I guess it's the coolest thing I've ever seen and I'm personally grateful for all of you science trolls. Just bring it on.

Dave: I just had to say that. I don't know where that came from. That was the dark side of gratitude.

Divya: There's always a dark side.

Dave: Divya, I love that you brought those up and your answers there mimic Game Changers, my new book. I hired a statistician and we went through 450 answers from people who are at the top of their field like you are and said what are the commonalities and the advice that these people have that have helped them to get where they are in life, so instead of doing this one person did it, I think I'll copy that. It's like everyone agreed on these priorities. Here's the techniques that you might use to get there so that if you have extra capacity for upgrading something about yourself, what would you do first to get the most ROI on it and what came out of that was 46 different laws for things that matter, and that's why I'm telling everyone listening. If you haven't bought Game Changers yet, order it now, and you have a chance to win a bunch of cool stuff if you send them online but if you just order it, you're going to get all 500 or so episodes all boiled down to four hours of your time, best you could ever do and of course, I'll send you a copy as well.

Divya: Thank you.

Dave: Well, thank you for being on Bulletproof Radio.

Divya: Yeah, it's been awesome.

Dave: You're very hard to track down. You only exist on LinkedIn. You don't have this weird thing called social media because it's bad for your brain. Is that why?

Divya: Also, it makes it easier for groups like NASA to kind of troll me and say that something was posted but not of them. I can't keep a really clean presence out there on the internet.

Dave: All right, well you've succeeded, I'm glad we got to connect in person at XPRIZE, and that you're doing the work you're doing. It's really important that we have people thinking about it in as big way as you are, especially around consciousness and brain waves because if we get one thing to make the world a better place, it's bring people to a state of higher consciousness, what's going on inside them around them, because when you're aware of everything, you probably won't let it get as bad as you would if you didn't know about it.

Divya: Yeah.

Dave: Keep doing your work. Thank you very much. You've been listening to a Divya Chander, and you can only find her on LinkedIn.