

Speaker 1: Bulletproof Radio, a state of high performance.

Dave: You're listening to Bulletproof Radio with Dave Asprey. Today's interview is with one of the leading researchers in the world looking at circadian biology, which is how your body responds to night and dark cycles. When you listen all the way through to the end you're going to learn so many different things you can do to improve the way your body functions that don't have a lot to do with exercise or any of the things you might expect. There's just tons of really good information from one of the guys doing the in the trenches work with some powerful stories filling it in. You'll enjoy this one.

Today's cool fact of the day is that 50 years ago scientists were first able to create synthetic DNA, 50 years ago. They produced a type of viral DNA called Phi X 174, which is an extremely simple molecule with only five or six genes, but that laid the foundation for the synthesis of more complex DNA, including the whole genome, even semi-synthetic organisms, and who would have thought 50 years ago? Things do change quickly, but this was before I was born. This is a huge achievement since the structure of the DNA molecule was discovered only a few years before they did this in 1953, and that was discovered by none other than Francis Crick.

Today's guest is a friend of mine, Satchin Panda, who has perhaps the coolest name of any research scientist that I've come across. As you might have guessed, he grew up in India, but he's a professor at the Regulatory of Biology Lab at the Salk Institute. I had a chance to spend several hours with him and his team last year looking at mitochondrial cells in rat retinas, and just getting the geekiest tour I've ever had of cool research going on. Satchin is considered one of the Top 50 influential scientists in the book called Brain Trust. His discovery is among the Top 10 Breakthroughs of the Year in a science magazine. He has just gone through and done research about the profound impact of ambient light in your daily eating and fasting cycle on preventing a huge number of diseases, like diabetes, depression, metabolic syndrome, heart disease, cancer. He is running a large research study right now through an app called My Circadian Clock that monitors and modifies circadian rhythms.

One of the world's leaders in understanding how light programs your brain, your body, your mitochondria, and he actually booked the coolest room ever for this interview. Satchin, welcome to the show and tell me where you're sitting right now.

Satchin: Hi Dave, I'm actually sitting in the old office of Doctor Francis Crick. Many of you know that Francis Crick was a core discoverer of our DNA, and this is actually his office where he worked until the end of his life as president of the Salk Institute. Just behind me, on my right side, is the replica of the Nobel Prize that was given to Francis for the discovery of DNA. On the back on the wall there are also framed copies of his letter to his son describing the discovery of DNA, and how DNA makes this double helix turned. It's interesting to see Francis writing this long letter and at the end signing, "Love, Daddy."

Dave: Well, there you go. Francis Crick definitely had love in his life, and it's now been documented.

Satchin: Yes.

Dave: One of the highlights of my year was actually touring around in your lab. We didn't get to go by Francis Crick's office when we were there, and just looking at electron microscopes and seeing this is what rat mitochondria look like when they're doing this versus doing that, and just really getting into it with some of your research students, but I think people listening to the show today, by now most of us have heard about circadian rhythms because of all the news about the Nobel Prize this year being awarded for research in circadian rhythms. It's now entered our national consciousness, but can you define what a circadian rhythm is, in a way that ... for people who maybe have a vague sense that it's something to do with day and night, but what is a circadian rhythm?

Satchin: They all need to know the name circadian rhythm comes from two Latin words, it essentially means approximately a day or a 24 hours rhythm. These circadian rhythms are found in almost every living animals, plants, and also many microbes that are on the planet. Due to rotation of our planet around its axis for 24 hours this [inaudible 00:05:01] a profound pressure on every organism to adapt to this predictable change in day and night, every day for hundreds of millions of years. That's why for example plants raise their leaves and drop them down in every 24 hours. Birds, animals, humans, we all go to sleep and wake up in 24 hours. These 24-hour rhythms are so ingrained to our life, that if we take one animal or plant from our planet and put it into Mars or any other planet that has a day and night cycle other than 24 hours, will have a hard time to survive. That's so profound. These rhythms are so profound that we have to have them to survive on our planet.

Then you might ask, "Why do we have circadian rhythms?" Well, one thing is have you ever tried doing two different tasks at the same time? For example texting and driving or those kind of stuff, where two things actually don't match. You might be able to do for a while, but that's not the best way to do, but at the same time there are different tasks that go together. For example listening to Bulletproof Radio and sipping some Bulletproof Coffee, they go together.

Dave: Okay, I'm not going to argue with that one.

Satchin: Similarly, like eating dinner and talking to your friends and family, those things go together, whereas many things that don't go together. Just like that in our body when we go to sleep or when we wake up or when you go play sports there are many things, many genes, many hormones, many brain chemicals that have to work together. For example when you go to sleep at night our sleep hormone melatonin should go up, our muscle tones would go down so that we can sleep nicely, we should not act out our dreams. Conversely, during day time we need less melatonin so that we feel less sleepy, more cortisol, and then our muscle tones would go up, our heart rates would go up. These things go together. Circadian rhythms, essentially make sure that compatible things go together and they're timed to the right time, and in compatible processes separated between day and night. That's the basic principle or basic reason why we have circadian rhythms.

Dave: Why is this more important knowledge now than it was 10 or 20 or a 100 years ago?

Satchin: Well, if you think about human ... our existence on this planet for hundreds of thousands of years, we did not have actually artificial light or electrical lighting, and lighting up was very expensive. For example, you just dial back 100 years or 150 years, at that time a lot of people really didn't have access to modern lighting, they were using well oil, kerosene oil, or different types of oil to light up. It was very expensive to light up two to three hours in the evening. People are more in tuned with the day and night cycles, their internal rhythms were in sync with our day and night cycle. Over the last 200 years or 150 years, we are experiencing more disruption to our circadian rhythm because we have access to light. We can light up anytime we want, it doesn't cost much, and actually for an average, American, we spend less than 0.1% of our income on lighting. This is that cheap.

Then what happens is as we have light becomes an enabler to stay awake at nighttime and boost up some stuff. If we look at what is circadian disruption or how much disruption is bad for health? How many nights in a year we can stay awake? That will actually cause dramatic health disturbances. Then we can go back to one group of people who do it almost on a daily basis, there is the shift, those are the shift workers, the people who work day and night shift. We know that those people are at a high risk for circadian disruption and many chronic disease. You might argue that, "Well, the shift workers also don't have access to healthy diet, and they might be more stressed." We go back to laboratory condition and we can animals who have a natural mutation in their circadian clock, [inaudible 00:09:57] induced mutation, and those animals with circadian disruption because of their genetics, they also are at a high risk of various diseases, starting from diabetes, obesity, cardiovascular disease, even anxiety, ASD-like symptom and cancer.

We can also take people and put them in isolated room and disrupt their circadian rhythm, don't let them sleep for more than five hours or so, and within a few days, a few weeks, a couple of weeks, they will start to show all these signs for chronic diseases. That's why we know that circadian rhythm disruption is bad, but I will say there are at least six different ways, we all experience circadian rhythm disruption, and almost everyone of us is a shift worker. The group number one is what I call the card-carrying shift workers, these are the people who actually do shift work, the police, the security people, the military-

Dave: Doctors.

Satchin: Workers, doctors, and emergency first responders, etc.

Dave: Software developers.

Satchin: I'll get to that. In fact 20% of workforce in any industrial country is shift worker. One in five go through this for years because that's the profession they chose. The second, curiously, funnily I call them the secondhand shift worker. That's somebody's spouse, a shift worker's spouse might be more loving, caring, care to stay awake to give company

for late night dinner or a very early morning breakfast, or might actually give company to stay awake very late into the night. They're not shift workers, but by staying awake they disrupt their rhythms.

Then you might ask, "How many days in a year you can disrupt your rhythm and be classified as a shift worker?" The definition is kind of loose from one country to another country, but there is a nice European definition and I like that, and that is if you stay awake for three hours or longer between 10:00PM and 5:00AM for 50 nights in a year, then you are almost a card-carrying shift worker. You might ask why 50 nights only and there is 365 days, and if you disrupt your rhythm for 50 days what happens? The interesting thing is the day we stay awake for three hours in the middle of the night we know that, that day we've disrupted our clock, but it takes almost five to seven days to come back to our normal rhythm. Even though we may try to go to sleep at the same time and wake up, still our internal clocks are so disrupted from one night of staying awake that it will take six to seven days. 50 nights of staying awake for three or more hours around midnight will cause damage.

The third group I would say is jet lag, the classic jet lag when you fly from East Coast to West Coast, and if you fly over three time zones then it will take you three to four days to adapt to the new time zone, and then you're coming back another three time zones, and it will take you three more days. Essentially if you do East Coast, West Coast 50 times a year, that would actually give you a nice card, that's a gold card or a medallion card, or a United 1K, all those frequent flyer, high flyer card-carrying travelers are also going through chronic circadian disruption. That's called the chronic jet lag.

Then I'll come to the fourth group and that is digital jet lag. This is where the programmers and stock analysts, and stock brokers, they come into place. They're in US time zones but they're tracking Asian market or something else and they have to stay awake, or they have to wake up in the middle of the night, or you can also take diehard sports fans. Suppose you are a fan of American football and you are living in India or in Asia, then you have to wake up in the middle of the night to watch your favorite sports live, similarly a lot of people who live in the North America and they have to track cricket scores, they also stay awake. That's digital jet lag.

Then the fifth one, which is the most pervasive one, I call them social jet lag. That is high schoolers or college students, people like you and I when we meet friends we stay up late into the night and go for a drink, a couple of drinks, or students who are staying up late into the night doing their homework, preparing for exam, for three or four nights in a week they stay awake beyond one o'clock, and in the weekend they're trying to catch up. They are essentially living in one time zone in the weekdays and another time zone in the weekend.

If you combine all these five categories ... six different categories, traditional shift workers, secondhand shift worker, jet lag, digital jet lag and then social jet lag, we can put ourselves in any bin. That means almost all of us at some point in our life go through this one to five years of chronic circadian disruption.

Dave: There maybe another category, which is younger kids because they make school start at 7:30 in the morning, which seems to ... like that is not what the biorhythms for kids are. I've been posting a lot of studies about academic performance when you make, especially high school students, wake up really early to start school before work time it just wrecks them biologically. That seems like that might be a seventh category.

Satchin: That's kind of in the last category, what I call social jet lag, where it's not social actually, it's kind of the academic performance they have to stay awake late into the night, they are doing their homework and also texting, and chatting with their friends, which is also part of their life. Then they have to wake up at six o'clock in a cold morning and then go to school. That's really something so profound that it affects almost 50 billion kids who go to school every single day. This is why we're also working to demonstrate what is the benefit of changing school start time, although we see a lot of stuff that we should start high schools later in the day. There is very little data to show that it actually benefits them. Once we accumulate those data, very objective, collected with scientific rigor and randomized, etc., the hopefully we can convince almost every school district to start the school late.

Another thing that happens when kids are ... this is good that you brought up that point, when kids or young adults they go through this circadian disruption, that's not their choice, it's imposed on them. The same thing happens in colleges. Then we pick up bad habits just to stay awake late into the night or to get somewhat few hours of sleep when we have a chance. People start drinking or getting into different drugs to keep them awake or go to sleep. Even though later in life we have a regular day and night cycle, we are still stuck with that bad habit. That's why in [inaudible 00:18:00] circadian disruption pushes us towards adapting some bad habits that can stay with us for the rest of our life.

This is the reason why I think this is very important that we learn more about circadian rhythm, because our body is designed, almost every gene in our genome is designed to go up and down or turn on and off at different time of the day. All of our hormones go up and down at certain time of the day. Our brain chemicals rise and fall at certain time of the day and there is no escaping from that. We are designed to go through certain lifestyle, but the world that we have created, the anthropogenic or the man-made world that we have created demands us to disrupt this natural rhythm. We cannot go back to the Stone Age, we cannot turn off all the lights and just live under day and night, the natural day and night cycle, but if we learn about what disrupts circadian rhythm and how we can nurture rhythms, then we can still live in this modern society and have a nurturing circadian rhythm so that we can be healthy, we can prevent diseases or even reverse some of the diseases.

Dave: There are so many things that your work and that of others, have teased out, like different environmental variables that affect our circadian rhythm, that part of my craft of biohacking is to recognize I am going to fly. I'm not going to live a perfect circadian life, but if I can avoid harming my circadian rhythm more than necessary I'll do that. My house at home, all of the exterior lighting is a sea turtle friendly red lighting. My friends think I live in a submarine or some sort of house of ill repute, but I can go outside and red light doesn't affect circadian rhythm. I can still see the stars and the side effect is

that I don't attract bugs with those, but I have three species of owl that nests within a 100 yards of the house because I'm not disrupting their circadian rhythm. It's like this external light pollution affects not just us, but every living thing on the planet, right?

Satchin:

Yeah, exactly. This is actually discovered almost 15, 16 years ago. We know that there is a small, very small number of nerve cells in the base of our brain, they act as master clock in our brain. These 20,000 neurons are literally hardwired to our retina, well, eye, and there are only a very small subset, maybe 5,000 to 10,000 special cells in our retina that sense only blue light, mostly blue light and they send that information back into the master clock neurons. That's how we are designed, not only us as you pointed out, almost every animal is designed to synchronize their internal circadian clock with the sunlight or day and night cycle, because sunlight or daylight is the richest source of blue light out there. That's why we are designed to synchronize our clock with blue light.

That very simple understanding that blue light synchronizes our clock has a huge impact, because as you pointed out in modern living condition we spent a lot of time in the evening in front of bright screen or bright light. Most of those lights also have a significant amount of blue light, that blue light suppresses melatonin, it confuses our circadian clock, our clock doesn't know whether evening has already started or it's just twilight zone. Think of like our body is in constant twilight zone. We get sleep disturbances, and similarly outside light pollution can disrupt rhythms in many birds, in many migratory species, they cannot migrate at the right time, they can be predated. They can completely be wiped out because they get confused which season it is.

That simple idea it's kind of interesting that in 15 to 16 years that simple discovery that we made in mouse, and then later on other people verified it happens in humans, has led to your cellphones now tuning to orange color around ten o'clock at night. This also has a huge impact because we know that the amount of light that comes out of the iPad, iPhone or any kind of smart screen is enough to disrupt our circadian rhythm, but if we change that light color that will have a huge impact. It's gratifying to see a basic science discovery has made it to a billion or more smart phones, and people are actually starting to use that knowledge.

Second, as you pointed out the next revolution will be this lighting evolution where we can have [inaudible 00:23:02], so that we can change the color of the light depending on the time of the day, but at the same time we move around. Let's say in the evening we have to, sometimes we go to the grocery store or we'll go to a drug store and we'll drive around. That's where we got to bring in another layer of defense and that's security in sunglasses or you can say evening glasses.

Dave:

When I go shopping at night it drives me nuts, I wear a baseball hat and circadian glasses. I started a circadian glasses company called True Dark, for that reason, but once you're used to having darkness and you go into a grocery store or any kind of department store you realize there is so much light. It's like brighter than daylight in those stores and it feels unpleasant once you're used to knowing that it's dark. I think most people haven't adapted that practice yet, but I can tell you, you sleep better if you don't go shopping at eight o'clock at night because of that.

Satchin: Yeah, no, once you go there to [inaudible 00:24:03] department store or grocery store you spend 15, 20 minutes shopping and then you are standing in line for another 10, 15 minutes, that's half an hour of super bright light. We know that if we bring people to lab and give that amount of light we can disrupt their circadian rhythm, we can reduce their melatonin. Essentially by going shopping late at night to a very bright store, you are essentially reducing your hormone levels. It's almost equivalent to, if you think of the environmental factors, for example carbon monoxide is regulated, carbon dioxide is regulated because that has huge impact on our health. If light impacts our health so much shouldn't we regulate light? Should not we come up with building guidelines that this would be light level?

I think these are the new issues that will slowly come up, and in fact the National Institute of Health had a workshop, and brought all the leading scientists to get together and discuss about the effect of light at night, and what kind of guidelines can we develop to improve health. I'm glad that you pointed that out.

Dave: It's funny at the Bulletproof Coffee Shop in Santa Monica we've had color treatable lighting. We have a big light box around the door that changes color what time of day for a circadian timing, and our new Bulletproof Headquarters has a low pressure ... sorry, low voltage halogen lighting on dimmers, and backup LED lighting so we can add red and amber towards evening time. We can dim the main light source and change the richness, and it's not that expensive to do this. If people know, when you're putting a lighting system if you know it's important ... We actually saved money doing it that way compared to the super high pressure LED system, that would have been installed by default. It is something, if you're going to redo the lights in your house you better think about color spectrum and temperature, and things like that.

Have you looked at LED, like white LED versus fluorescent, versus halogen, versus incandescent and what they do to circadian rhythm?

Satchin: Well, there are a lot of studies going on those kind of light sources, and in fact three, four years ago a bunch of us, including lighting engineers, architects, ophthalmologists, and physicians, primary care physicians and scientists, lighting manufacturers, we all got together in Tokyo and came up with a statement, Fujisan statement on LED lighting, and that was published last year. It's very true that light has a huge impact and people can do very simple things, just like you, you had a lot of sound bites, one is being able to switch. Well, you might have a lighting fixture that you don't want to get rid of, but at the same time you can just change the switch, put a dimmer. I think people, they should remove their light on/off switch, that is so last millennium, and then put dimmers.

Dave: Every switch in my house has them. That's exactly right. Now this may make dirty electricity, you're going to need electrical filters to remove EMF's if you do it, but the trade off is worth it in my experience. Your house is all dimmable then?

Satchin: Well, my house has very old lighting, most of our rooms have very dim lights to begin with. We don't even call them dimmers, and then the few lights where they came in built with dimmers, we have so dim light. People who come to the house, they think that we are in prehistoric age or something, but it's good because I feel sleepy-

Dave: Our house is the same.

Satchin: Between nine and 10, and I have a 15-year old daughter, and she has perfect circadian rhythm, she goes to sleep early, gets up early, and then goes to high school. Everything is fine just by changing one simple thing. People should start thinking about buying those dimmers.

Dave: Now we talked about going to bed early, waking up early, I've interviewed Dr. Michael Bruce, who's a sleep doctor, who focuses on non-apnea things, and he's got a theory that about 15% of people are, their chronobiology is wired to keep them up late. The theory is that if we were in a cave society you need a night shift, and 15% of people are the morning shift, they need to wake up real early. Then most people are daytime, and then some people never sleep very well, they're the back-up alarm system because everything wakes them up. Those are his patients.

I changed my circadian rhythm about, before I had kids, this was 10 plus years ago, and I made myself wake up at 5:00 AM every morning, go to bed earlier, and I did it for two years straight. I became an early morning riser person, and I was controlling my light, not as well as I do now. I was using plain amber glasses back then versus, now I have all the spectrums filtered out and all that. I did this for two years, and I found it didn't necessarily improve anything, maybe my creativity went down a little bit, and when I control my light and my food intake, so my body knows it's nighttime, but I'm wearing the glasses that make my brain think it's pitch black. I will naturally stay up 'til exactly 2:00 AM every night, and I've tracked this for seven years on sleep monitors. I get profoundly sleepy. I go to bed at 2:00, I wake up around 8:00, maybe 8:30, and that seems like the circadian biology no matter what I do, that's when I perform best and I feel best.

Do you think that there is any validity to that idea that some people have a later shift in circadian rhythm, some have an earlier shift to circadian rhythm? Could that be biologically based or do we just not know enough?

Satchin: Well, actually that's a very interesting topic that you brought up. Just like you said you're naturally designed to, wired to go late, and there are many people who are naturally wired to go late, and in fact-

Dave: We call these the good people, right? The very best people. No, I'm just kidding.

Satchin: Now almost 20 years ago this was not even considered that we are designed to go early or late. In fact there was this woman, I'm forgetting her real name. She went to many sleep doctors and said, "Well, I have this problem that I cannot resist, I just go to bed very early." She used to go to bed around 7:30 or 8:00, and she would wake up around three o'clock or two o'clock. She was a really early rise. Then the sleep doctor say, "Well, you are already getting seven hours of sleep so you're perfectly fine. There is nothing wrong with you. This is all in your head. This is some [inaudible 00:30:46], don't worry about it. There is no cure. This is not a disease."



She went around many sleep doctors and finally she came to a sleep doctor in Utah, in University of Utah Medical Center, and this sleep doctor had a good friend who is a human geneticist, and he thought that maybe there is some truth to it, maybe there's a genetic mutation in this person. He talked a good friend of mine, Louis Ptacek, and Louis used to do, and still does very good human genetic research. This guys Chris and Louis, they were biking and they talked about the story and Louis got super excited. He went and talked to this wife, Ying-Hui Fu, who is also a human geneticist, who was working on neuro disease, and they both were excited. Because they though, "Well, this is something really cool because if there is a sleep gene that times your sleep to different time that would be cool to discover."

For the next three to four years they put all their time, resource, and effort on figuring out what is wrong with this woman, and finally they found a mutation in the circadian clock gene called Period 2. The bottom line is when this gene is mutated then this people who had that mutation they go to bed very early. As they publish this very groundbreaking paper almost 17, 18 years ago in 2000, a lot of people started calling them and saying, "Well, I have a natural tendency to go to bed super late or I can sleep with only four hours or five hours, I'm fully functional." They got a lot of human mutants and they have been publishing a lot of papers identifying new genes. There is another gene if it's muted, then those people can sleep only for four to five hours and they are completely perfectly functional. That's a gene that makes you need less sleep. Similarly, now the new mutations people are finding that will keep you awake. It's possible Dave, that you are a mutant.

Dave: It's entirely likely given that half of my family comes from Roswell, New Mexico, the other half worked in the nuclear power industry their entire lives, it has to be that. Now here is a question, put on your 50 years in the future hat, are we going to be using Crispr gene editing so I could get the upgrades, so I only need five hours of sleep?

Satchin: I wish. Well, the point is yes, we got to know about our gene and how they regulate us, and at the same time sometimes our behavior daily is also much more profound. It's almost like driving a car. When we buy a car, different brands of cars have their own strength and weaknesses, and we know that we can put a very good tire or we can live with a tire that it can wait, and we just have to be careful about where we drive. We should not take our truck off-roading. Similarly, I think what we can do right now on a daily basis is to really take care of the circadian rhythm. Just imagine even if you have the best car, best Ferrari, if you take it off-roading everyday then it will very quickly lose its value. Similarly, I might have a very old-fashioned Beetle or something, and if I take good care of it then I can drive it to the moon, 240,000 miles.

When it comes to that, as you pointed out just taking care of light exposure or less light during night time, of more light during the daytime is really key to keeping our brain circadian clock functional. Similarly, almost nine years ago we made another big discovery.

