Health Benefits of Extreme Hot and Cold Temperatures:
A Special Interview with Rhonda Patrick, Ph.D.

By Dr. Joseph Mercola

JM: Dr. Joseph Mercola
RP: Rhonda Patrick, Ph.D.

JM: How can exposure to extreme temperatures serve as a catalyst to improve our health? Hi, this is Dr. Mercola, helping you take control of your health. Today I am joined by the renowned scientist, Dr. Rhonda Patrick, who we’ve had on our site before and who is really a phenomenal expert and devours the literature. She’s actually in the process of transitioning from Dr. Ames’ laboratory in Oakland, California and moving on to new ventures. We have her in her home today. We’re going to expand on this.

Welcome and thank you for joining us today, Dr. Patrick.

RP: Thank you for having me, Dr. Mercola. It’s a pleasure to be here again, the third time we’re having a conversation.

JM: Yes. I think our readers really loved you and your expertise. I certainly enjoyed our conversations, because of your just so passionate devour of the literature. Really not just reading it, but integrating it and providing it with practical recommendations based on all the science, because there’s so much good information going on.

We’re going to talk a little about a follow-up of what we did on our first interview, which is mitochondria as it relates to the exposure to extreme temperatures both cold and hot. We’ll get into that in a moment. But I think the mitochondria. I just want to expand on that a bit, because I think it’s such an central core of what’s going on.

Again, the mitochondria, for those who don’t know, these are these energy generators on our cells. We have far more of them than we have bacteria. We have about 35 trillion bacteria (that’s a new updated number) and as many cells in our body, about 35 trillion cells. We used to think we had a lot more bacteria. But what most people don’t realize is that we have a lot more mitochondria – literally, 500,000 times more. Maybe 15, 25, or 50 quadrillion mitochondria.

When those things are not working right, you’re not generating energy. The key is to get the old ones out and create new ones, which is a process called mitochondrial biogenesis. There are a number of strategies that can do that. I’d like to get your perspective on them.

There are four really profoundly effective ones that I’m aware of: 1) exercise, 2) exposure to extreme temperatures, 3) intermittent fasting or time-restricted feeding, and then of course, 4) supplements like resveratrol, which actually some researchers call an exercise mimic, because it has a very similar mechanism. I believe they all stimulate the peroxisome proliferator-activated receptor-gamma co-activator 1 alpha (PGC-1 alpha), which is the primary driver for mitochondrial biogenesis. This is something we want to activate for sure.
Of those four, I’m wondering maybe you can expand a little bit about the biogenesis because it does enter into our exposure to extreme temperature. But then also maybe rank them and sort through as to how effective each one is. I know resveratrol is one of your new passions. I saw one of your recent interviews on Joe Rogan.

Initially, I was intrigued with resveratrol because it stimulates [inaudible 03:15] and it’s all great. Then I got disenchanted with it. But now this new research is coming about mitochondrial biogenesis. I’m like, “Whoa! This is great,” so I’m taking it three times a day now. Maybe you can give your perspective on that. I’d appreciate it.

**RP:** Absolutely. I do think that mitochondrial biogenesis is a very important function in our body because, as you mentioned, the mitochondria are what’s generating all the energy that every single organ in our body is using to do its function.

Whether we’re talking about our brains, that our brain can function; our heart, so our heart can beat and pump blood throughout our bodies, so our blood cells can bring oxygen to our tissues; or our lungs, so we can breathe in oxygen – all these, everything that your body is doing on a daily basis is being run on the fact that these mitochondria are producing energy. The more mitochondria you have, the better.

Also, as we age, we tend to lose more. The mitochondria become damaged. They’re very susceptible to damage, because they are generating energy. This process also generates byproducts that damage the mitochondria themselves. It’s really nice if you can get rid of the old damaged mitochondria and bring in new ones that are younger. This mitochondrial biogenesis is very important.

You actually did hit four different means or modalities of increasing mitochondrial biogenesis. If I were to rank them, I think that I will probably say the cold… Exposing our body to extreme temperature changes, either cold or hot, I would say cold probably is no.1 for increasing mitochondrial biogenesis.

**JM:** Really. Interesting.

**RP:** We can talk about that in just a minute as to why. Then heat and exercise, I think pretty much, they’re up there. I can explain the mechanism for that. They’re kind of similar, depending on the intensity of exercise and the type of exercise. We can also get into that. Then followed by the resveratrol, I think. That’s in my mind.

**JM:** You left out the intermittent fasting.

**RP:** Oh, the intermittent fasting. Yeah, actually, the intermittent fasting. I don’t know, but in terms of intermittent fasting and resveratrol, maybe intermittent fasting and resveratrol are pretty similar, depending on the dose of resveratrol and the length of the intermittent fasting. But the intermittent fasting does increase mitochondrial biogenesis. If you’re doing it for 16 hours or definitely for 48-hour intermittent fasting, which is pretty extreme (and obviously, if you’re going to do that, you need to talk to a medical physician).

**JM:** It’s actually not what I recommend, because of protein metabolism. You don’t want to lose your protein.

**RP:** I agree. But I would love to kind of talk about this concept of why this stress… These are all stresses: exercise, cold, heat, fasting, and resveratrol even. Why is it that stressing the body has so many good ramifications, why are there so many good things that come out of it, including mitochondrial biogenesis?

**JM:** Is it due to hormesis?
RP: Yes, exactly.

JM: OK.

RP: Hormesis, would you like me to define it for everyone?

JM: Absolutely yes. It’s a new term for many who have just heard this word.

RP: Yes. Hormesis, what this refers to is a process of exposing your body to a very short burst of stress, whether that’s exercise, heat, cold, fasting, or resveratrol. Because it’s a short burst of stress, your body reacts to this stress by activating a variety of stress response pathways that we have hardwired and encoded in our genes. It turns them on because they’re thinking, “I got to prepare for war. This is stress. I need to make sure I fight this off.”

Not only does it activate all these really good pathways to fight off the stress that you’re dealing with immediately, but it is preparing for future war. It’s basically thinking to itself, “I may encounter this stress again. I have to activate all these good pathways that can help me deal with stress. That way, the next time I encounter it, I’m ready to fight it off.”

That’s really one of the main reasons why short bursts of stress are so good for you, because we have so many amazing genes in our body that are so powerful. The problem is that as we age, they don’t become activated as often. We need to find ways to activate them more, to turn them on, so that they’re doing all this good stuff.

JM: Terrific. What I neglected to mention when I introduced you is that you have a website called FoundMyFitness.com – all one word, no hyphens. You have your own Podcast and reports that you have. You’ve done two of them on these topics: one is on heat stress or these infrared saunas or saunas and then the cold stress.

For more information, you can go to the site. We’ll put links here, so that they can go to your site to get those free reports that go into great detail. Literally, if you put them together, it’s close to half a book. You don’t have to pay for it. It’s great. I love them, because they’re up-to-date science and your writing is simple, easy-to-understand language. It’s not complex.

But why don’t you try to summarize those now and maybe explain the differences between the heat and the cold stress? Because they’re both really useful.

RP: They are. They are really useful. With the heat stress, when you’re exercising, you’re also heat-stressing your body. You’re elevating your core body temperature. That’s why you’re sweating when you exercise. Or when you get into a sauna or a steamer, or even if you’re sitting in a hot bath, something that’s also going to make you sweat, it’s going to elevate your core body temperature.

This causes your body to have a stress response that’s really good. One, it tries to activate genes that are important for making sure that your proteins inside of your cell are the best that they can be. That’s really important because your proteins inside of your cells get damaged with time.

This leads to plaques, aggregates, and things like that in your brain, in your vascular system. It activates these genes that make sure that your proteins don’t do that, that they don’t aggregate and form plaques in your arteries or in your brain.

They’re called heat shock proteins (HSP). They’ve been shown to be involved in longevity as well. People who are more likely to live to be a hundred have a gene that makes them have this active more often. It’s really good to have these heat shock proteins.
They’re important for also preventing your skeletal muscle from atrophying, because they prevent proteins from being chopped up and degraded. In your skeletal muscle, keeping on your muscles is sort of a balance between making new proteins and making sure your proteins that you already have aren’t being chewed up and degraded quicker than you’re making them.

As we get into about the middle age, we lose about .5 to 1 percent muscle mass a year. That’s alarming. Because when you start to lose muscle mass, you become more frail. You can fall down and break something. That can eventually take you out when you’re older.

JM: Sure.

RP: I think that methods for maintaining muscle mass are really important. In fact, studies have shown, at least in mice that are exposed to a little sauna, when they’re exposed to the sauna, they actually can increase their protein synthesis by 30 percent compared to the mice that are not being exposed to the sauna. This was shown to be dependent on the heat shock proteins, HSPs, in the muscle.

JM: There have been studies that looked at different types of heat stressors like soaking in a really hot bath or a Jacuzzi versus infrared saunas, steam saunas, exercising. Is the barometer just your sweating ability? I think you would sweat less if you’re on water, because you’ve got another way to dissipate your heat. Has that been looked at, the comparison between those?

RP: Unfortunately, no. There has not been a direct comparison of the different modalities for heat-stressing your body. A lot of the research that I have looked into and read have been done with dry saunas, the kind of sauna that you can find in a gym.

JM: The typical.

RP: Yeah, it’s a typical sauna. But I do think the important thing here is the actual heat stress. You want to feel uncomfortable. You want to feel hot. That’s when you know that these good pathways are getting activated.

The other thing that happens in terms of mitochondrial biogenesis and the reason why it occurs when you’re exposed to heat is that heat itself, as I mentioned, is a stressor on the body and it creates reactive oxygen species (which I know you’ve talked about and we’ve talked about in the past), the same thing that are generated when you exercise, when you’re causing your body to work more. These reactive oxygen species are what actually act as a little signaling molecule to make more mitochondria. It’s very important.

If you exercise and you take a supplemental vitamin E or something that can sort of soak up the reactive oxygen species, what happens is you can negate some of the positive benefits from exercise, because you are now not getting those signaling molecules that are saying, “Hey, we’ve got stress here. Let’s make more mitochondria to deal with the stress. Let’s activate all these good genes to deal with the stress.” It’s really important that you actually have some of that stress. That’s part of the mechanism by which it increases mitochondrial biogenesis.

The heat also has very robust and profound effects on the brain. When you’re in heat, your body wants to cool itself down. Your body goes, “OK, I’m hot. I need to cool myself down.” It increases the production of something in your brain that can cool the body down. It turns out, what it’s doing here, this thing that cools your body down is actually something that sensitizes your brain to the feel-good endorphins.
That’s because this thing that is expressed when you’re hot to cool your body down is called dynorphin. It’s actually the opposite of the endorphin. They’re part of the same family, but it’s responsible for that dysphoric feeling that you feel when you’re hot, when you’re exercising. It’s responsible for the dysphoria feeling when you’re under the sun. You’re like, “Oh, man, it’s just so hot. I want to get out.” That’s a really good thing.

JM: Would that be true for really cold, too? Dynorphin?

RP: No. I think for cold, you actually increase norepinephrine more.

JM: OK.

RP: We can talk about that. Because dynorphin cools you down. You wouldn’t want to activate something that’s going to cool you down more when you’re already cool; you’re going to do the opposite. But the dynorphin is good because it helps… It’s part of this hormesis thing.

I think what’s really important for people to understand is everyone’s always trying to avoid stress. Everyone always wants to avoid stress. They want to be comfortable. I think that the reason for that is people are aware of the fact that chronic stress is bad. That is absolutely true. Chronic stress is bad.

When you’re constantly non-stop having a stressor, you don’t have this positive hormetic response to it. What ends up happening is that all shuts off and all you have is this bad stress. A lot of bad things happen. You start to get more anxiety, or you become apathetic, depending on which end of the spectrum.

But the short burst of stress is really good. With the sauna and the dynorphin, it’s kind of uncomfortable and you feel uncomfortable. But what’s happening in your brain is it’s going, “Oh, I’ve got this stuff that’s making me feel bad. I need to increase that other stuff that makes me feel good. I need to increase that pathway.”

It has this sort of feedback mechanism where it increases the expression of a receptor that binds to endorphin called the mu opioid receptor. You make more of these receptors. That way, the next time you produce endorphin, you’re more sensitive to it. There are more receptors and they become sensitive. You actually can relieve anxiety.

This is something that I have actually experienced firsthand. It’s what actually got me interested in the sauna in the first place. I noticed when I was doing the sauna in a period of my life that was very stressful – graduate school was very stressful for me. I would go to the sauna before I went into the lab. Before I went into the laboratory to do my experiments, I would go to into the sauna. I cannot express to you the difference in how much less anxious I was.

I would go into the lab, my experiments failed. It wasn’t such a big deal that six months of my life were down the drain and we had to start over, or that I had 10 people yelling at me to do 10 different things. That didn’t get to me as much. I felt a lot like I was more resilient to that type of stress and I could handle it. It was very noticeable. That’s what actually got me reading about the sauna. Because I realized something’s happening in my brain, I need to understand what’s happening, so I started reading about it.

Since we’re talking about the brain, another interesting effect of the sauna is that, because it’s a stress and your body is making these damaging reactive oxygen species, it’s very stressful to the body, that also affects your brain. The way your brain responds to a short-term stressor – this is the same for exercise as well – is it increases the production of growth factors.

The reason it does that is it’s preparing for war. Growth factors make more soldiers, because they allow you to have more neurons. When you increase the production of growth factors in your brain, like brain-
derived neurotropic factor (BDNF), that causes neurons to make more neurons. Your brain is thinking, “I need more neurons to deal with this stress, because my neurons are my army.” It’s really cool that you can actually go in the sauna, you can exercise.

This is having a very profound effect on brain aging, because as we age, we start to lose neurons in many regions in our brain. That’s also a really important part of the sauna. It’s also very important, as I mentioned, for longevity. But it also has a very profound effect on the heart, cardiovascular health.

Did you read that study that came out of Finland? There was a Finnish study that was published last year that prepared Finnish men… Sauna’s very big in Finland and so is jumping on icy lakes. They like to do both of these. But men that used the sauna two to three times a week had a 27 percent lower mortality rate for heart disease and had a 24 percent lower all-cause mortality, meaning they died less from cancer, heart disease, lung disease, neurodegenerative disease, all diseases. That was two to three times a week.

Men that used it four to seven times a week had a 50 percent reduction in mortality related to heart disease, and they had a 40 percent reduction in all-cause mortality. It’s very profound, because you’re talking about a dose-dependent response, which means the more frequent you’re doing something, the more robust, the bigger the effect is with the sauna.

The question then becomes why is it so good for the heart? For anyone that has sit in the sauna before, they’ll realize immediately that as you start to get hot, your heart starts to race. Your heart starts to beat between 100 and 150 beats per minute, which is mimicking cardiovascular exercise. You have increased plasma volume, so you’re getting more plasma; your blood vessels dilate; the cells that line your blood vessels, your smooth muscle cells, they relax. That’s very good for your heart health.

All these good cardiovascular changes are happening as you’re getting in the sauna. I think it’s quite possible that some of these cardiovascular benefits from the sauna have a lot to do with this effect, the effect that heat itself is doing.

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That’s also what exercise is doing. When you’re exercising you’re doing the same thing. You’re getting the vasodilation. Your heart rate’s going up. Also, your smooth muscle cells that line your blood vessel are relaxing. All these good things are happening. There are a lot of really great things with the sauna.

**JM:** Yes indeed. Now, have you heard of exercising with oxygen therapy or EWOT?

**RP:** No. What’s that?

**JM:** It’s when you’re exercising and you’re breathing in air through a mask that’s usually brought by a high concentration of oxygen, so that you can get large volumes of it. It’s very similar to hyperbaric oxygen therapy.

**RP:** I’ve seen people do that. I didn’t know what it was.

**JM:** Yes. It’s called EWOT.

**RP:** EWOT.

**JM:** I suspect because it’s a cardiac stimulus that’s causing you to get the benefit, the combination of that. It’s probably beneficial if you’re in a sauna. It would be SWOT, sauna with oxygen therapy.

**RP:** Interesting.
JM: I don’t think anyone has studied that, but it would be an interesting combination. I also wanted to make a comment on (which I think is an important topic) the reactive oxygen species mentioned earlier. There’s a tendency for many people, especially 20 years ago when all these high-dose antioxidants, vitamin C, vitamin E, and a whole variety of others are taken, and they not discriminatedally suppress reactive oxygen species.

Of course, in excess they’re dangerous. But I believe the best way to optimize that is to not generate them in the first place. Ideally, you do that through an optimized fuel, by not eating dirty fuel. Dirty fuel being excess carbohydrates; clean fuel, of course, being fat and ketones.

It’s interesting though that these hormetic stressors like exposure to extreme temperatures and fasting actually generate their own reactive oxygen species, which, as you said, are these really profoundly powerful signals to the molecular biology of the cell. Without them, they really disturb profoundly the metabolic physiology of what’s going on.

I think it’s an important concept, this hormesis or hormetic stressors that you’ve really defined and really are helping people understand. Using those as the antioxidants, sort of your intrinsic antioxidant effect.

RP: Exactly. I think you bring up a really important point. Because I think some people can get very confused. As you mentioned, we’ve all been told that reactive oxygen species, that’s what you don’t want. The difference here is it’s true, you don’t want it; but you don’t want it a constant drip all the time when you’re eating a diet that’s high in refined carbohydrates and low in good micronutrients – things that are good sources of fuel – or when your gut health is poor.

When you have this constant stress, it’s no longer a signaling molecule, because your body is always getting it. It’s not surprised. It doesn’t think it’s going to war. It doesn’t have any reason to activate or have a hormetic response. Instead it’s just like, “Oh, this is always here.”

It’s different when you’re optimizing to have the best mitochondrial function that you can, feeding your cells the precursor they need, making sure you’re not eating things that are damaging your gut health and causing inflammation, and making sure you’re eating things that are not damaging your mitochondria.

But instead when it’s time, you have this short burst – for 15 minutes, 20 minutes, an hour, or whatever – of stress that all of a sudden your body’s going, “Whoa! We need this big burst of reactive oxygen species.” It now becomes a signaling molecule and tells your body to turn on all these good things to deal with the stress. It’s very different from the chronic type of stress that you’re talking about.

JM: Just to comment, too, on foods that damage your mitochondria. What occurred to me instantly were toxins. The most pervasive toxin that the majority of people are exposed to – probably not the people listening to this; they are already aware of it – would be non-organic foods that are sprayed with Roundup, which not only has glyphosate but surfactants that make it 10 to 100,000 times more toxic. They’ve been shown to be directly toxic to the mitochondria. Absolutely. That’s why you want to eat organic. Another good reason.

RP: You know the reason I actually like to eat organic?

JM: It tastes better.

RP: Here’s the reason I like to eat organic: we’re talking about hormesis here. I really want people to understand this concept, because it’s just so important for longevity and for resilience. Exercise, obviously people get that it’s stress. It’s stress on the body. You’re getting good benefits from it.
Plants actually make their own natural insecticides, and they make them in order to ward off insects, fungus. These plants have evolved for millions of years to do this. This is what they do. These plant compounds – resveratrol is one. There’s a variety of other plant compounds – curcumin, EGCG, these things that people know. They’re called polyphenols.

**JM**: Polyphenols. They’re all polyphenols.

**RP**: Right. Polyphenols, flavonols.

**JM**: There are thousands of classes.

**RP**: Exactly. What those actually are: they’re stressful on us. They’re natural insecticides that plants make to ward off little creatures.

I know there are multiple studies probably, but the one that I’m familiar with is the one that was done on blueberries. Resveratrol is something that’s made to make sure that you don’t get fungus. It’s mostly on grape skin, but blueberries have a little bit. They have like 10 percent or something the amount of resveratrol in grape. They make some.

But the thing is that if you spray a pesticide on the fruit, on the blueberry, it doesn’t feel the need to make more of this natural pesticide because it’s already got something on it. It’s been shown empirically that blueberries that have been grown organically versus that that have been sprayed with an insecticide or an antifungal make less resveratrol.

I actually like organic because I want more of those horstic compounds. I want more of those natural plant insecticides, because they’re doing good things in me.

**JM**: Interestingly, an extension of that would be… And really in my experience, anyone who’s passionate about health ultimately becomes passionate about gardening and regenerative agriculture or regenerative gardening.

You’re really paying attention to the microbial communities that are growing in the soil because that is what nourishes the plant and allows it to optimize its genetic potential. It’s all based on the soil health. It’s not adding Miracle-Gro; it’s mycorrhizal fungi and a whole variety of other interactions that occur that really feed them and allow it to maximize the production of these defense mechanisms against insects and other predators that actually are beneficial to us when we eat them in small hormetic quantities.

**RP**: You’re making me jealous. I’m a city dweller and I would love a garden. My in-laws have a phenomenal garden, and I’m very jealous.

**JM**: I’ve got about a quarter of an acre. I’m in my third year of regenerative agriculture experiment, about 60 trees. I grow most of the food that I eat actually, which is a pretty interesting experience. Right now, I live in Florida, and I’ve got mangoes. I’ve got one mango tree that has like 600 mangoes on it, and it’s only like 7-foot tall.

**RP**: Oh, my goodness. What?

**JM**: Yeah. It’s incredible.

**RP**: That’s incredible.

**JM**: This is just magnificent. When you really pay attention to the structure of the soil and these things like biochar, which is really profoundly effective form of carbon that serves as homes for the bacteria and other microbes, and then adding other mineral, nutrients, and composts. Ugh, it’s just incredible. It’s just
a miracle to see, because every day, it gets better. Like most things, like your house and stuff, there’s entropy and degeneration. It just gets worse. You got to maintain it. But with your garden, if you feed the soil, everything gets better. It’s like this abundance.

**RP:** That’s an interesting way of looking at it. Plus, it’s also good exercise and probably meditative. It probably is like a stress reliever, where you’re kind of just in the zone, you’re in the flow.

**JM:** The zone, from my perspective, is just to have a phenomenal appreciation of the magnificence of plants and what they can produce if you just take care of them properly. It’s a fascinating experiment. I think you’d love it. I really do.

**RP:** Let me seed an idea in your head.

**JM:** Sure.

**RP:** A friend of mine who does his own gardening was talking about possibly stressing plants a little more to cause them to make more of these hormetic compounds to make more resveratrol, to make more apigenin or whatever we’re talking about. It’s kind of an interesting concept. I don’t if any study has ever shown that to be the case. It makes sense.

**JM:** It does make sense. But my response to that is there are enough stressors already in the environment. They’re continually stressed – too much sun, too cold, too little rain, not having enough water, insects, fungal disease. I think there’s this constant exposure to stress when you’re in a natural environment that’s not really different. Now, that might be true for artificial environments like hydroponics.

**RP:** Right.

**JM:** I don’t think they have the same exposure. There, they might have a more profound effect. I’m not a big fan of hydroponics at all. I know that it has some benefits, but I think it’s really producing far less nutrient-dense foods than you can in the soil.

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**RP:** Of course. There are trace elements, minerals, and all these things that are very important. That’s why plants, green plants, have magnesium. They’re getting these things. They have selenium. They’re getting it from the soil.

**JM:** Or you can put that in the water. But still, the other microbial interactions that probably catalyze these production of beneficial nutrients that we have no idea that are in there.

**RP:** Right, of course.

**JM:** Anyway, it’s a little bit of a tangent. I think we should go back to the exposure to extreme temperatures. But you hit one of my hot buttons there, at least tangentially. I think maybe if we can talk a little bit about the cold exposures, because that’s another really intriguing… I know you’ve interviewed Wim Hof actually in his hometown in Norway, was it?

**RP:** Amsterdam.

**JM:** Amsterdam. OK.

**RP:** The Netherlands.

**JM:** The Netherlands. He’s very intriguing. That’s spelled V-I-M H-O-F.
RP: W-I-M.

JM: W-I-M. Sorry. It’s pronounced “Vim” but it’s W-I-M H-O-F. Your interview with him was very intriguing, on your site. Tim Ferriss interviewed him. Joe Rogan did an interview with him. An interesting character. You were the science person. The other people had no idea what they’re talking about, but you did. You really kind of grounded him in reality. I enjoyed that. But anyway, he has one type of exposure. He’s an extreme, of course.

RP: Yes.

JM: Why don’t you summarize the evidence and what the rationale for seeking to apply this type of stressor, hormetic stressor here?

RP: Absolutely. I love these hormetic stressors and temperature changes. It’s sort of one of my little pet interests. Exposing your body to cold also has a lot of positive benefits. It’s been popularized, at least, by the media that cold exposure is like this hack that you can do to help you burn more fat. I think that’s probably what most people associate sitting in an ice bath or taking a cold shower is doing. They’re like, “Oh, I’m going to increase my metabolism to burn more fat.”

There is truth to that. That’s probably the least… I’m interested in that, but I’ve never, you know. I think the way to regulate your weight, the amount of fat you have, and all this is actually through diet. Diet’s the best way.

JM: No question.

RP: Right. However, there are benefits. The hormetic part of this cold exposure is what’s really important. The reason that you burn more fat when you’re cold actually has to do with mitochondrial biogenesis. Maybe I’ll start explaining this and I’ll get into some of the other benefits with cold that I’m a little more interested in than this as well.

Because when you’re cold, when your body is cold, what it wants to do is get warm. It wants to basically stay alive. It doesn’t want to die. You don’t want to get hypothermic. There’s a very profound response mechanism that occurs when you cool the body. That is your body makes the production of a hormone and a neurotransmitter called norepinephrine. It produces norepinephrine in the brain, which is involved in focus and attention. It also improves mood. It’s often used to treat depression as well as attention-deficit hyperactivity disorder (ADHD).

But in the body when you make it, it acts as a hormone. It does a lot of things. It causes vasoconstriction. The reason it does that is your body is trying to conserve heat. This is one of the ways your body goes, “OK. I’m cold. I’m going to conserve heat,” increases norepinephrine and norepinephrine then causes vasoconstriction, which then uses less heat. You’re basically conserving what you have.

The other thing that norepinephrine does is it’s a signaling molecule to basically make more mitochondria. It causes your body to make more mitochondria in your fat tissue. Because your fat tissue, that’s your reserve stores; that’s your energy reserve. That’s where you have your reserves for energy. Your body wants to make energy because when you make energy, the byproduct of energy is heat.

Your body goes, “OK. Time to ramp up fat metabolism, because I need some of that heat to warm myself.” The way it does it is by increasing the norepinephrine, norepinephrine sends a signal to your fat cells, and your fat cells activate a gene called uncoupling protein 1 (UCP1). Sorry for the jargon, but you’ve probably seen it. It’s all over the popular media.
UCP1, what that does is two things: number one, it causes your mitochondria in your fat cells to make more mitochondria. This is often referred to as browning fat. The reason it’s called browning fat is if you take a fat cell and you look at it under a microscope, the more mitochondria it has, the browner its color looks. Because the mitochondria are so dense, they give it this brown sort of coloring.

**JM:** It’s actually what turns… The difference between white meat and dark meat. The dark meat would be more active muscle with more mitochondria.

**RP:** Exactly. That’s a great analogy. That’s what it’s doing to your fat. Basically, there are a couple of benefits from that: the first benefit is you start burning fat. Your body starts to get fat and metabolize it to generate energy and heat. It’s doing that more, because now you have more mitochondria to be able to do that.

The second benefit is that the reason why it does that is it’s preparing for the next time it’s going to be exposed to cold. The more times people are exposed to cold, the more mitochondria they make in their fat cells and the more they can withstand the cold.

This is where Wim Hof comes in. Because he has a lot of brown fat, he has a lot of mitochondria in his fat cells, because he’s been exposing himself to cold on a daily basis for decades. He’s now able to withstand the cold for a longer period, because he can make more heat. The more mitochondria you have in your fat, the more fat you’re burning, the more heat you can make, the longer you can stay in the cold. That’s sort of the science behind how you can actually stay in the cold for a longer period of time. That’s a great benefit.

**JM:** Now, when you expose yourself to heat, you make something that you referenced to earlier, heat shock protein. My understanding is that you also make heat shock proteins when you expose yourself to extreme cold. But there’s another, there’s a cold shock protein, which is known as the RNA-binding motif 3 or shortly called, RBM3. Why don’t you expand on that? I think it’s another intriguing example of hormesis.

**RP:** Yes, it is. Thank you for pointing that out. It’s one of my pet topics that I enjoy. Because when you are exposing yourself to the cold, you do increase heat shock proteins, because heat shock proteins are responsive to stress in general, thermal stress. But they are more robustly activated in heat.

Then there’s a whole class of proteins called cold shock proteins. One in particular that you mentioned, RBM3 is in the brain. The really cool thing about RBM3 is that it’s doing a very important function. When you’re exposed to the cold, you actually degrade synapses, which are the connections between neurons. It’s how your neurons are communicating with each other.

But RBM3 completely regenerates them. It regenerates all those synapses that were lost in the cold. This has been shown in hibernating animals like bears and squirrels that hibernate. They very, very robustly increase their cold shock proteins. They activate it in their brain, and this regenerates the lost synapses.

There’s this really great study was published not long ago that showed that when you take a mouse, you genetically engineer it to get Alzheimer’s disease or a neurodegenerative disease, and then you expose it to cold, so that it’s increasing RBM3, it delays the onset of the Alzheimer’s disease. Even though they were genetically engineered to get Alzheimer’s disease, they get it much, much later. That’s really cool.

It’s also shown to increase the number of synapses. Alzheimer’s disease, you actually lose synapses. As you age, you lose more and more synapses. But the RBM3 was able to maintain those synapses.

Obviously, we’re not mice. A lot of work to be done. However, there have been some studies in human cells that have shown that RBM3 does get activated when the brain cells are exposed to cold and that the
cold temperature change just needed to be around a degree and a half or something like that in Fahrenheit, which is also achievable in humans.

It’s a very intriguing idea. There needs to be more research done. But it still sort of raises this important question about does exposing your body to cold, is there some sort of neuroprotective effect in your brain, and is it good for your brain? I would argue that, yes, it is. In addition to the RBM3 and the cold shock protein, the norepinephrine in your brain also is very good. It’s also an anti-inflammatory. It decreases inflammation in the brain, in the body.

Like I said, it’s involved in focus and attention. Also, it improves what’s called long-term potentiation, which is basically what happens when you have a synapse. It strengthens that connection between the two neurons. It makes it stronger, so that you can remember something.

[----- 40:00 -----]

Norepinephrine regulates that process. It’s really kind of neat that cold… You can actually increase norepinephrine by two-fold just getting in a 40-degree water for 20 seconds or getting in 57-degree water for a few minutes. It’s really easy to sort of get in a cold shower.

**JM:** And it’s less expensive than an antidepressant and probably more effective. At least some antidepressants, because certainly a big percentage of them are serotonin reuptake inhibitors (SSRIs). There are some, especially the earlier ones that focus on norepinephrine.

**RP:** They’re serotonin and norepinephrine reuptake inhibitors. I think those are sort of coming back now, the combination of the two, where they’re both serotonin and norepinephrine.

Also, norepinephrine alleviates pain, partly because it lowers inflammation. It decreases the production of TNFL, a very potent cytokine, which I’m sure you’ve talked about in great detail. But it dramatically decreases cytokines, so that you’re not activating all these immune cells.

Inflammation causes pain. That’s why a lot of anti-inflammatories can help alleviate pain. But also humans that have had back pains have had norepinephrine injected into their spine, and that alleviates the pain as well. There is sort of this analgesic effect that happens with norepinephrine as well, which I think has to do with the lowering of inflammation.

**JM:** Because we talk about pain a lot on our site, especially with this epidemic of heroin overdoses and secondarily believed to be related to the wide abuse of prescription pain killers. Pain needs to be taken care of. Ideally, you need a solution for it. But it’s very rare where one ever recommends cold stressors to decrease the inflammation and improve the pain.

**RP:** It really is rare. I think that it’s something that some people are starting to find that it helps. I’ve talked to some people who have said that it helps with their arthritis pain, their mother’s arthritis pain, or something like that. I’m trying to get my mom to do it. It’s always a challenge, but I think once a person experiences the benefit, they realize that wow, this is easy. This has no negative side effects but positive side effects. Because the hormetic stressor, it’s activating all these good response pathways that we have hardwired in us to help us deal with stress.

It causes us to be more resilient. I think that it’s something. It makes me feel good. I challenge people. If you just wake up tomorrow morning or sometime this week, and you just get in the shower, dial it down to cooler water, and sing or do whatever (sometimes, I sing and I say, “This is good for my brain.”), something to help you stay in that water. Just do it for a few minutes, as long as you can. See how you feel afterwards. See how you feel.
I would think that you’re going to feel really good because the norepinephrine that gets released, it’s an antidepressant. It makes you feel good. You feel good. Those effects last throughout the day. I’ve dug a lot into the science behind this, but I’ve also experienced this first hand.

In fact, any time I’m doing something that’s very anxiety-provoking, if I’m going on a big show or something where I’m going to have a bunch of eyeballs looking at me and I get really nervous, I’ll take a cold shower. Guess what? I perform better because I’m less anxious. It’s helping. It does help me.

**JM:** Interesting. I find personally that taking a deep breath and holding that breath and then exposing yourself to the stressors help with the transition. Because typically, within a few seconds, certainly 5,10, 20 at the most, your body sort of adjusts to it and you adapt. Then you relax and then you’re OK. You’re adapted.

**RP:** I didn’t get too technical about this because I don’t want to lose people. But part of that adaptation has to do with the browning of your fat. It’s basically called thermogenesis. Because you immediately start making more mitochondria when you’re exposed to the cold in your fat as a protective mechanism to not die (because your body wants to generate heat), you immediately start doing it.

What you’ll notice is that some people, the first time they’re exposed to cold… There are two ways your body can generate the heat or can increase metabolism to generate the heat. The one we talked about— that is the browning of that. The other way is non-thermogenesis, is non-shivering thermogenesis, which basically means that your muscles start to twitch. Your muscles twitching, that is an energetically costly thing that happens. You have to burn energy for your muscles to twitch, so you’re making heat. That’s not very thermodynamically favorable. It’s better to make more mitochondria and burn fat.

**JM:** Sure.

**RP:** The first time they’ll do that, they’ll shiver. But if you expose yourself again, you’ll adapt quickly, you’ll start to make mitochondria, and then you can handle the cold. It becomes easier and easier to do. That’s really neat as part of the adaptation.

**JM:** I think that’s called the uncoupling of the energy production. There are certain ethnicities like those from Africa that are exposed to these highly extreme temperatures and have this uncoupling. When they move to countries like this, they are liberating all this heat and it’s not very efficient. Sometimes they believe that’s one of the reasons why they’re generating more reactive oxygen species.

Because if you’re using it, it’s not a problem; if you’re not, it’s a major problem. That’s one of the reasons why they have these increased risks of all these degenerative diseases, because they’ve got this massive increase of reactive oxygen species and secondary free radicals.

**RP:** Interesting. Yeah, I did know that there are different people that have variations in the genes. The uncoupling, UCP1. Exactly, UCP1. Yes, but on the mitochondrial biogenesis topic, did you want to dive into the fact that it also increases mitochondrial biogenesis?

**JM:** Absolutely. One of my favorite areas is mitochondrial biogenesis.

**RP:** You mentioned the PGC-1alpha when we were first talking.

**JM:** Right. Because you see, I love PGC-1alpha, one of my favorite proteins.

**RP:** Then you’re going to love the cold, because it increases PGC-1alpha.

**JM:** Yes, right. You said that from your review that that was probably the most potent stimulus of PGC-1alpha.
RP: Yeah. It’s one of the most potent stimulus.

JM: Wow.

RP: The reason for that is if your body thinks that it’s going to die… Exercise obviously is a stress. But cold will kill you.

JM: People die from hypothermia all the time.

RP: Right. It will kill you. When you start to cool your body, your body freaks out, and it says, “I got to gather all my troops. I got to do everything I can to fight this war, so that I stay alive.” One of the ways it does that is by increasing mitochondria in multiple tissues. It also does it in the muscle. You actually make more mitochondria in the muscle. This happens through PGC-1alpha.

You’re also making more mitochondria in the muscle which is really good for multiple reasons. Obviously, the more mitochondria you have, the more energy you can produce, the more muscle mass you can maintain. These things are all very good. But I do think the cold itself is probably one of the most potent stimulators of mitochondrial biogenesis.

Now, of course, this probably also largely depends the temperature, the duration. I’ve done almost everything. I’ve jumped in the Pacific Ocean in the winter. I’ve done cold shower. I’ve done ice baths. I’ve done whole body cryotherapy. I’ve done all those things and they all make me feel like I have more norepinephrine. If you’re getting that norepinephrine, I think that’s a good way to gauge whether or not you’re getting that cold shock response.

JM: Sure. A slight tangent with exercise, because it is a caution, not so much for cardiovascular but certainly for strengthening exercise. When you exercise, you generate these signals, these reactive oxygen species that, especially for resistance training, increase muscle mass. If you have a cold exposure, within the first hour, you’re going to suppress that, which is very unwise to do. You want to not have these cold exposures immediately after strength training. Potentially, cardio I think it’s OK, maybe even helpful.

But I’m wondering if you have the exposure not around the strength training, sort of independent of that. Because of the stimulus of the mitochondrial biogenesis, PGC-1alpha, if that will help muscle growth.

RP: Thank you for pointing that out because it’s a very important point. Whereas doing the sauna after exercise actually can increase muscle mass.

JM: Detox too.

RP: Yeah, it does. It helps you sweat out BPA, phthalates, mercury, and other heavy metals and all that stuff. You’re not going to prevent the signaling molecules that are generated from exercise from doing their positive thing if you get in the sauna.

But if you get in the cold, immediately after exercise – this is what’s important to understand. Like we talked about exercise is a stress, a stress on the body. You’re making reactive oxygen species. You’re generating inflammation. But that’s a good thing because it’s a short burst, and you want it.

This happens within an hour. It’s been shown in multiple studies. There’s an hour timeframe from the time you stop exercising, an hour later, within that hour is the peak pro inflammation. It’s that stressful period. But then as soon as an hour hits, the stress response kicks in and you start to have an anti-inflammatory. You start having an antioxidant response from activating all these genes.

[----- 50:00 -----]
What happens is that because the cold also is causing an anti-inflammatory response, it’s important that you don’t get that anti-inflammatory response to soon, because you need some of that inflammation. You want that inflammation to happen to get the anti-inflammatory response. That’s important for the strength training. The reason that is important is that the inflammation that you generate during the strength training is part of the mechanism for making more proteins in the skeletal muscle. If you blunt that, then they’re going to blunt the effects of the strength training. That has been shown before.

The question is then can you do it an hour or two hours later? The other studies have shown: yes, you can do cold exposure, cold water immersion and get actually some performance enhancements even from doing [that]. Those knee extensors, is that what they’re called?

**JM:** Leg.

**RP:** Leg extensors.

**JM:** Extensions. I think the one hour window is a really important observation and probably the window where you want to therapeutically use nutrients, specifically amino acids to also enhance muscle building. That would be the branch-chained amino acids – leucine, isoleucine, and valine – primarily leucine, which is the most potent stimulus for muscle growth.

I’m not a big fan of using them. I’d rather use them in food like in a high-quality whey product. I do use them personally. After strength training within the first hour or just typically a half hour, I’ll have a fairly significant dose of these branch-chained amino acids, leucine primarily, through high-quality whey products. I think it’s a good window. That’s only time I use them. I think if I use them otherwise, they’re potentially dangerous. They actually can activate mammalian target of rapamycin (mTOR), which will inhibit mitochondrial biogenesis.

**RP:** Yes.

**JM:** But it’s all about timing. Timing is key.

**RP:** That’s interesting. There’s a 24-hour time period that you can take up branched-chain amino acids after exercise, but you’re right.

**JM:** Right after is going to be better.

**RP:** Right after is going to be better.

**JM:** The same reason with cold. You’ve empirically, anecdotally proved it with those cold observations. That’s the window.

**RP:** Yes. In terms of the endurance, it doesn’t seem to be as important. However, for whatever reason, all the scientists that are doing research looking at the effects of cold water immersion or cryotherapy on endurance athletes, they’re always rating an hour for some reason, which is very strange, except for the ones that are doing it between two bouts of exercise. If you’re doing a swim, then you’re doing a bike ride or a run, it’s kind of like two bouts of exercise. It can improve your performance on the second bout, which makes sense.

**JM:** Sure. There is more information obviously on your report. We’ll get into how to retrieve those again. But one of the reasons I really enjoy dialoguing with you on these topics is not because you’re just so smart, but you’re able to actually digest it, synthesize it, and give us a practical perspective.
I’d like your comments on a principle that we strongly advocate, which is to listen to your body, to respect what signals it’s giving to you. This is a fine balance. Maybe there is no answer, but I would appreciate your opinion.

Because this stress, a form of this stress, it’s uncomfortable. Of course, you mentioned that we need to explore those areas. What would you recommend to explore that discomfort? Because at some point, it actually can be damaging. You need to honor if your body is telling you to back off. How do you put your toe in the water, so to speak, and begin to reap some of these hormetic benefits, which are truly profound and virtually free in most cases, with your understanding of how to use them. Do you have any advice on how to reconcile that potential conflict?

RP: Yeah. First of all, I think it’s important to mention that people who have any sort of medical condition, you need to talk to your doctor obviously. I hate saying that for obvious reasons. But these are stressors, in particular the cold stress.

Whereas the sauna can be very beneficial for people with different cardiovascular-related diseases, because of the vasodilation and the whole mechanisms of increasing the blood flow, helping the blood pressure and all those things.

Cold is a little different, because cold is causing vasoconstriction very acutely, just very acutely. But if you have some sort of heart condition, that’s something that does need to be considered, because that can be potentially dangerous. That is something that I would warn people with heart conditions. Maybe a quick cold shower’s OK, but don’t get in an ice bath or do anything really extreme. Obviously, talk to your doctor.

But with that said, in general, it’s really, really good to listen to your body. You need to recover from the stress; otherwise it’s not going to be beneficial. If you’re exercising all day, every day, you’re going to die. You can’t constantly keep stressing your body without a recovery period, which is part of the reason why sleep is so important for recovering you, repairing all this damage that you generated throughout the day.

I tend to push things to the extreme. I’m getting better with that now. But I have experienced, with myself, when I’ve sat in an ice bath for several minutes, I start to feel light headed. I shouldn’t be feeling light headed. That’s enough. I need to get out. The same with the sauna. Feeling uncomfortable is good. You want to push a little bit past that comfort and feel a little uncomfortable. That’s important for some of the hormetic benefits. But you don’t want to faint.

Never bring alcohol in the sauna. Ever. Don’t drink in the sauna. Don’t drink before you get in the sauna. It’s not good. Not good. But you do need to listen to yourself. You don’t want to go overboard. I think for me, if I feel fainting, light headed, or anything sort of weird, that’s it; that’s enough. Done. You need to really be careful and just listen to your body. Listen to your body.

JM: Great. That helps. That information is I think not in your report. Let’s get back to those reports again. It’s on your site, FoundMyFitness.com. No hyphens, all one word. FoundMyFitness.com. It’s really easy to find. I listen to all your Podcasts regularly, because there’s just so much... It’s such a pleasure. I really enjoy. I’m just a passionate learner.

I get great insights from you. If you like health, you’re crazy not to subscribe to her channel. Then you’ve got lots of great free reports, especially with respect to our conversation because it’s relatively short. There’s literally, like I said, at least a half to three quarters of a full book for free if you download both of these reports. There’s no charge for them.
If you found this topic intriguing, and it’s hard to imagine that you wouldn’t. There’s just a lot of solid information in it. It’s not expensive stuff. It’s a simple strategy that would keep you healthy, which is why I love it. It’s just basic stuff.

**RP**: The cold stuff that we talked about today, the Cold Stress Report that I put out is 20 pages. It’s a lot of good information. It is free, but I ask people to sign up for my newsletter, but you’re going to get more good information.

**JM**: Why wouldn’t you want that? Why wouldn’t you want to do that? You don’t sell products and stuff. It’s just solid science related to health. Obviously, if you listened this far, you know what type of information and the way you’re going to convey it. It’s no different on your site. It’s the same information. I strongly recommend that. I really thank you for the time, really the insights, and the information. I’m sure it’s going to help a lot of people.

**RP**: Thank you, Dr. Mercola.

[END]