Importance of Mitochondria:
A Special Interview with Dr. Rhonda Patrick

By Dr. Joseph Mercola

DM: Dr. Joseph Mercola
RP: Dr. Rhonda Patrick

DM: Mitochondria: you might not know what they are but they are vital to your health. Hi, this is Dr. Mercola, helping you take control of your health. Today I am joined by Dr. Rhonda Patrick, who is a biomedical scientist. She has a PhD in that and has a very interesting history. She is absolutely passionate about applying what she’s learning in science and how it can optimize our health. Welcome, and thank you for joining us today.

RP: Thank you so much for having me, Dr. Mercola. It’s a pleasure to be here. I’m really excited.

DM: Most people probably haven’t heard of you before. Maybe if you can describe your specific training, some of your passions, and how you’ve acquired your expertise.

RP: Sure. As you mentioned, I’m a scientist. I did get a PhD in... Technically, on my diploma it says Biomedical Science but I did all of my graduate training at St. Jude Children’s Research Hospital, where I studied the interaction between metabolism, aberrant metabolism, and cancer. I’ve done a lot of research on cancer.

Previously, before I actually started graduate school, I was a chemistry major in undergraduate. In college, I did a lot of research on organic chemistry. Chemistry is fascinating but I felt like it was a little too far removed from biology and from my quest and my curiosity for understanding the human body. After I got my degree in chemistry at the University of California, San Diego, I decided to try working in the biological sciences, kind of get my feet wet to see if I enjoyed it.

I did some research at the Salk Institute for Biological Sciences in La Jolla, California, where I researched aging. I used a little nematode roundworm called the caenorhabditis elegan (C. elegan) as the research model for aging because they have a lifespan of around two weeks. So, it’s very easy to manipulate an organism that lives only two weeks because it’s not a very long time. If you’re going to do aging studies on humans, good luck. You know, you are talking an average of 80 years. So, I had a variety of experiences doing research on aging, cancer, and metabolism. Now, currently, I’m in Oakland, California, where I’m in my post-doctoral, working with Dr. Bruce Ames, who is a professor.

RP: Exactly, yes. He’s had quite a profound effect.
DM: That’s been around a long time.
RP: Long time, yeah. He’s a Professor Emeritus at the University of California, Berkeley but he’s still got a lot going in Oakland, at Children's Hospital Oakland Research Institute (CHORI), where the primary focus of the research there is the role of nutrition in preventing age-related diseases like cancer,
neurodegenerative diseases, and different inflammatory-related diseases like obesity and type 2 diabetes. I’ve been doing a lot of research currently on nutrition, specifically what roles of micronutrients, which are essential vitamins, minerals, fatty acids and amino acids that are very important to run your metabolism.

I’ve been looking at the role of micronutrients in variety of different important biological processes, how inadequacies and certain micronutrients can lead to insidious types of damage that can accumulate over decades (eventually in the fifth and sixth decade of life), [and how they] lead to things like cancer and Alzheimer’s disease. I’m looking sort of like at early biomarkers of those diseases, for example, cancer.

An early biomarker of cancer is damage to DNA. So, I look at damage to DNA in people with the hope of then trying to figure out if we give these people the right micronutrients, for example, magnesium. Magnesium is a very important mineral that’s needed for a lot of enzymes in the body to repair damage to DNA. If you don’t have enough magnesium around, then you may accumulate more of this damage, which you won’t notice right now. You can’t get up in the morning, look in the mirror, and see DNA damage but it’s there, it’s happening, it’s accumulating, and it’s insidious. You know, 10, 20, or 30 years from now, the end results of that damage is potentially cancer-causing mutation, which then can lead to a cancer cell, which then can grow, proliferate, and eventually form a tumor. You get the point.

DM: Sure.

RP: That’s my current research.

DM: It seems like some of your research is really dedicated and personally centered on your desire to optimize your own health and curiosity. You have the flexibility to do that, and the skill set and the mind to incorporate that. So, would that be a fair assessment?

RP: Yes, it is, absolutely. I am obsessed with learning. I just can’t quiet my brain. I just hunger to learn more. There’s definitely a selfish component to it. I want to learn how to optimize my own cognitive performance and my athletic performance. I want to also increase the youthful part of my life. I want to be 90. I want to be out there, surfing in San Diego just like I was when I was 20. I would like to not degenerate as rapidly as some people do. I like to stave off that degeneration and extend the youthful part of my life as long as I possibly can so I could enjoy life.

DM: Well, I sensed that when I was watching some of your other podcasts and I resonated with that immediately because that’s what actually drives me. It’s like we’re resonating the same frequency from that perspective, which is why I’m excited to connect with you.

One of the areas of your earlier research was on mitochondrial function and metabolism. That’s actually been one of my recent passions too. I emailed her earlier book. I read Dr. Lee Know’s Life - The Epic Story of our Mitochondria, which is a good primer for those who haven’t read them in some other papers. But it just seems that this is really to understand the mitochondria and the influence of it has such an enormous potential to influence our health, specifically cancer. I think it may be the core of effective cancer treatment. It’s to optimize mitochondria metabolism.

RP: Well, you nailed it, Dr. Mercola. Mitochondria are the major source of energy in every single cell and every single organ in our body whether we’re talking about our brain, heart, liver, or kidneys. The functions of these organs… In order for these organs to do their functions, it requires energy and that energy is made from mitochondria. So, mitochondrial function is the heart, the very heart of everything, everything in the body.

Yes, understanding mitochondrial function, optimizing mitochondrial function, making sure to prevent mitochondrial dysfunction, making sure you get all the right components and all the right precursors you
need for your mitochondria to work optimally, and making sure that you’re not doing something to cause more damage to the mitochondria are extremely important for cancer, neurodegeneration, gut health, brain function, and everything. It’s endless.

DM: Let’s just take a step back because there are a fair number of people here who don’t have biomedical training, and they may have heard of mitochondria but have no clue to what it is. We’ll just give a little definition. These are little, tiny organelles. Originally, thought to be derived from bacteria and every cell has from about a hundred to 100,000. That’s a lot of mitochondria inside every one of your cells, 10 trillion cells. As you mentioned, they generate the power and the energy.

An interesting observation that I wasn’t aware of until recently is there’s been this dramatic focus on the molecular biology of cancer and this tremendous emphasis on trying to identify the genetics of it to manipulate that in some way to find some markers. There’s just enormous amounts of research, as you know, that go into that. But they’re not looking morphologically at what’s happening to the cells. If you do, it seems to be one of the universal characteristics of cancer cells is they have radically decreased numbers of mitochondria and functional mitochondria. That maybe is a clue that if you’re disrupting the mitochondria and addressing the mechanisms that do that, it may go a long way towards helping really not only to prevent but treat cancer.

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RP: Yes. I did a lot of work on mitochondrial metabolism, specifically in cancer cells. The thing is it’s so incredibly complicated and trying to figure it out is a lifelong project. So, it’s nice that a lot of different scientists and brain power are working towards that. But the mitochondria, they can still function in cancer cells. It’s weird. I don’t quite understand why cancer cells... One of the things that occur is they immediately become dependent on glucose and not using their mitochondria even though they have mitochondria there, which can function, but they make this metabolic switch. I have a sort of theory as to why that may be, if you want me to elaborate that.

DM: Sure, sure. Let me just interject here that this is not new information. Dr. Otto Warburg actually... As in biochemistry, you can fully appreciate... He was a German physician and has a PhD. He’s generally recognized as the greatest biochemist of the 20th century. He got a Nobel Prize for it. He also got three other Nobel nominations. He was a brilliant man, and he figured out that cancer cells actually use glucose, metabolized or fermented, anaerobically as a source of energy production, which is relatively inefficient. But they don’t use oxygen. They ferment glucose. So yes, let’s hear your theory.

RP: Right. I agree with you. Dr. Otto Warburg was brilliant. He was the first to make that discovery. Like you said, he won a Nobel Prize for it. What was really interesting about that is when he first made this observation that cancer cells do make the switch in a way they use and produce energy by not using oxygen and by not using their mitochondria, originally he thought it was because the mitochondria were all non-functional. But then he published a paper after that stating he was wrong and that the mitochondria are functional. They’re just not being used. So, it’s very confusing, and we still haven’t figured that out. We haven’t figured that out.

DM: Well, there are not a lot of people looking at it. That’s the issue. The emphasis isn’t on that. They’re really focusing on the molecular biology.

RP: It’s growing now. It’s definitely... As a graduate student, I was working on the metabolic underpinnings in cancer cells. There’s a whole group of people out there: Dr. Craig Thompson, for one, he is doing some really pioneering work. Dr. Ralph DeBerardinis, he’s also doing some great work on cancer metabolism, and Dr. Lewis Cantley. These are all scientists that are really pioneering some new research on mitochondria, cancer, and metabolism of cancer.
Just to circle back to my little pet theory, one thing about cancer cells is that they are damaged. They have acquired a lot of damage. There are a lot of genetic changes that have occurred both in the mitochondrial genome and in the nuclear DNA of these cancer cells. The body has a protective mechanism like it can sense when there is damage. When there is damage to a cell, a genetic pathway gets activated because the cell knows [and they’re like,] “Hey, wait. This isn’t good. This may potentially lead to cancer. I’m going to go ahead and try to kill myself. I’m going to undergo cell death as a protective mechanism to not get cancer.”

But cancer cells have found a way around that. They’re like, “Hey, you’re going to try to kill me so I’m going to increase all these other genes that are involved in preventing death.” So, it’s kind of like this balance between pro-death and anti-death, and they’re both raised. Really, cancer cells have this whole crazy genome going on where they have a lot of these pro-death signals going on. But at the same time, they have all these anti-death signals going on to counter it.

The mitochondria... When you are producing energy from the mitochondria... The oxygen that we breathe in is coupled to the food we eat. There’s a reason why we need oxygen and there’s a reason why we need food. That’s because those two processes, I know you know this, Dr. Mercola, are coupled together, and in process, just for learning, it’s called oxidative phosphorylation. That’s really what the mitochondria are doing. They’re taking the oxygen you breathe in. They’re taking the food you eat. They’re doing all this cool stuff together, and producing energy in the form of adenosine triphosphate (ATP), which essentially runs, like I said, every function in your body, from your brain function to your heart beating to your liver, you know, everything.

However, that process produces byproducts that are very damaging to the cell, to mitochondrial DNA, to mitochondria, to all your DNA, to your cells, to the proteins inside your cells that are doing all the function of everything...

**DM:** Cellular membranes.

**RP:** Exactly, to cellular membranes. Because mitochondrial metabolism inherently... The energy you produce from it, there’s a trade off because you’re also making damage at the same time. And this is part of normal... in metabolism. Normal aging...

**DM:** And probably beneficial. If you didn’t produce those free radicals, those reactive oxygen species (ROS), you’d be sick because you need those. They’re normal signals that your body requires.

**RP:** Yes, exactly. They are normal signals. But to a cancer cell, that reactive oxygen species is a signal. Like you said, they’re signals, it’s a signal for many things, for increasing good genes and antioxidant genes, that are involved in combating that. That’s also a signal for death so it activates these pro-deaths genes. Because, as I mentioned, the cancer cells are already... They have all the pro-death and they’ve made all the anti-death, a little bit more pro-death tips them towards death. In fact, that’s the mechanism by which chemotherapeutic drugs work.

The reason why chemotherapeutic drugs predominantly can kill cancer cells... They kill many different good cells and that’s a whole other cancer cell to get into. But one of the mechanisms by which these chemotherapeutic drugs work is because they create reactive oxygen species. They create damage and that’s enough to push that cancer cell into death. I’m wondering if the cancer cell doesn’t want... By the way, you can actually reactivate mitochondria through a variety of pharmacological drugs, and I’ve done this experimentally in the lab several times, and kill a cancer cell.

I think the reason for that is all of a sudden, a cancer cell, which is not using its mitochondria, meaning it’s not producing those reactive oxygen species any longer. All of a sudden you force it to use its
mitochondria and you get a burst of reactive oxygen species because that’s what mitochondria do, and boom, death. Because that cancer cell’s already primed to that death. It already is ready to die.

DM: Well, it’s a really interesting discussion. I’ve been a fan of intermittent fasting for quite some time for a variety of reasons, certainly longevity and health issues. But also, it appears that it has a really potent implication on the treatment of cancer. It appears the mechanism is through these mitochondria because especially...

I initially thought that intermittent fasting didn’t really matter on the timing and that skipping breakfast was probably the easiest way to do it but it seems that skipping dinner might be better because from a perspective of this... The processes you described earlier where there’s this normal side effect of energy production is the production of reactive oxygen species and secondary free radicals. It’s directly related to the amount of fuel that one is consuming.

So, if you’re consuming a lot of fuel at a time when your body has virtually no need for fuel, you exceed the capacity to compensate for these normal metabolites. So, you create an excess of reactive oxygen species. The classic example would be eating before you go to bed, when your body is relatively quiet and has the least amount of need for fuel, and you’re giving this extra fuel. It’s just like trying to, I guess, rev your engine, like a car, with a gas motor with the brakes on. It’s like not a good idea. You’re going to cause some damage and destruction.

It seems the really simple, easy, and effective strategy would be to implement something where you just don’t eat a lot food before you go to bed and have a certain amount of time where you’re essentially fasting.

RP: You know, Dr. Mercola, that’s very interesting that you bring this up. I’m sort of thinking about it from a different perspective but it’s also in line with what you’re saying. The way I always think about why you shouldn’t eat before bed, and it has to do with the mitochondria as well, is because of circadian rhythm, which is regulated by the day and night cycle (the sleep and not sleeping cycle). At night, your body is the least insulin sensitive that it can be.

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Eating a bunch of food later in the evening, your metabolism is all mucked up because all the genes that run metabolism are shutting down, on the genetic levels. In the morning, they’re turned on. They’re active. Your mitochondrial genes are like, “Give me some fuel.” They’re revved up. But in the night, they’re quiet. So, if you’re eating a large meal right before you’re going to bed or soon before you go to bed, there are a couple of things that are problematic. One is that you’re not very insulin-sensitive so you talked in great detail about that. Two is you’re probably going to end up... You’re going to store a lot of that energy as fat. It’s very interesting that you have made that observation with intermittent fasting and doing it.

DM: Well, yeah. I’ve been a fan for a long time. There are several researchers... Maybe you’re aware of some of them, Dr. Thomas Seyfried and Dr. Dominic D’agostino, who are really early proponents of that. You probably know others and can clue me in on those researchers. But they’re using this clinically to treat cancer. Interestingly, Dr. D’agostino is also integrating hyperbaric oxygen in addition to intermittent fasting to take advantage of the fact that these cancer cells do not like oxygen. So you’re like giving this double whammy. You could actually even integrate smaller amounts of chemotherapy and make the chemo far more effective at a much lower dose with virtually no side effects or far less side effects for sure.

RP: Yeah.
DM: So it’s an interesting strategy.

RP: Yeah. I think that part of… You mentioned Dr. Dominic D’agostino.

DM: Yes

RP: I am familiar with some of his work. I’m definitely familiar with, is it Seigfried? I never know how to pronounce it.

DM: It’s Seyfried.

RP: Seyfried, yes. Thank you. I definitely read a lot of his work when I was in graduate school because that was what I was... My whole thesis was about mitochondrial metabolism and cancer.

Anyway, I think that part of the mechanism by which fasting, through ketogenic diet, works is because when you’re fasting, your body has to rely on lipids and stored fats for energy which means they have to use their mitochondria. Your mitochondria are the only mechanism by which your body can make energy from fat. Again, it comes back to that activating the mitochondria.

I think that really plays a huge part in the mechanism by which intermittent fasting kills cancer cells, by which activating the mitochondria with certain pharmacological drugs that can kill cancer cells, is because now you’re creating that burst of reactive oxygen species, which is... Like I said, the cancer cells are just ready. They’re primed to die. They’re ready to die but they just need that little push. They need that little push to death. Of course, there are a lot of very other interesting mechanisms that occur when you’re fasting. Your body also clears away damaged cells through a process called authophagy, which basically means a cell that’s damaged, it can die. But if it doesn’t die, sometimes it becomes what’s called senescent and this happens a lot with aging.

What that means is that the cell is not dead but it’s not really alive. It’s not doing its function. It’s just kind of sitting around in your body and it’s secreting pro-inflammatory molecules, things that are damaging other nearby cells thereby accelerating the aging process because inflammation drives aging in so many different ways. Autophagy clears away those cells that are just sitting there creating damage and not doing much else, which is nice because that’s also a very important biological mechanism for staying healthy.

DM: Now, some people listening to this may be disinterested because they don’t have cancer or no one close to them has cancer, but let’s put this in perspective. The potential for cancer for all of us is very high. It’s one of the leading causes of death and the rate of exploding may even pass cardiovascular diseases in the not too distant future. It’s a miserable way to die prematurely and most people with cancer tend to die earlier. So this is one that will take out younger people. I mean, elderly die from cancer too, of course, but it tends to hit a younger population than some of the other degenerative diseases. Maybe you can comment on that for the reason why pretty much everyone listening to this should be interested.

RP: Yeah. Cancer, like you said, much later in life, it’s not... If you make it into your eighth decade of life, you’re 80 years old, you’re likely not going to get cancer. It’s something that hits around fifth and sixth decade, and it can hit earlier. It can hit sometimes in the third or fourth decade. I had a very, very good friend of mine who passed away when he was 34. He died of a very specific type cancer called mesothelioma.

DM: Sure. And of course, there are pediatric cancers. I mean, they’re just not as common.
RP: Right, yeah. Pediatric cancers are mostly cancers of the blood systems like leukemias and lymphomas. But you can get some muscle types of cancer like sarcomas, and also some brain cancers as well. But adult cancers mostly are solid tumors like prostate, ovarian, and kidney cancers.

DM: Breast [cancer].

RP: Breast cancer, exactly. Any sort of tumor or carcinoma or lung cancer, it’s something... It’s a terrible, terrible thing. You want to do everything you can in your control to prevent yourself from getting cancer. Because once you have cancer, those little guys are so smart and they are so bad. They will take over and it’s awful.

DM: Yeah. What we’re talking about are really simple strategies. In most cases, it essentially eliminates the risk of cancer, which is just profoundly phenomenal. I mean, it’s the goal that Nixon started in the ‘60s, this war on cancer, which has been a miserable failure, of course. Because it was too complex, it typically results in... You need a simpler strategy, you know, just optimizing mitochondrial health by the steps we are mentioning really seem to be a large part of the solution.

RP: Yeah, it is. Making sure your mitochondria... Your mitochondrial enzymes, majority of them require B vitamins as co-factors to function properly. For people who don’t know what that means, it means... If you think about your lock on your door, you have a key that fits right into that lock and will open it. But you can’t take your key for your door and go to your neighbors’ and open their door because the key doesn’t fit right. So the key is very important for the door to unlock or to lock. That’s the function of it, right?

Well, co-factors are essential minerals and vitamins that fit right nicely into an enzyme so that the enzyme can do its function properly. When you don’t have that co-factor there to fit in it, the enzyme is not doing its function very well. In the case of mitochondria, it will then lead to aberrant mitochondrial function. It will make more of those reactive oxygen species more than it should, which can lead to more damage. It can cause all sorts of problems.

The other thing is making sure you’re not giving it all the wrong stuff, right? You want to get the right stuff but you don’t want to get all these refined carbohydrates, refined sugars, and things that will damage the mitochondria.

DM: Sure.

RP: So, it’s important to make sure both things are...

DM: Most of the people watching this would be aware of those strategies because we talk about it all the time on our Website. We have for the last 20 years almost. But what I’d like to focus on is one of your passions and recent interest in these micronutrients and how they apply to mitochondria function. From your perspective, what you might view as the sort of the top essential nutrients you would use or identify to optimize mitochondria function?

RP: Yes. I think some of the important micronutrients to optimize mitochondrial function are one, B-vitamins. All of the B vitamins: riboflavin, thiamine, and B6.

DM: Really?

RP: They’re all co-factors, yes, yes. They’re very important for mitochondrial function. Something that’s very interesting is that as we age, our cell membranes become stiff. As you mentioned, some damage happens to cell membranes that damages the function...
DM: Is that reversible? Say a person with a typical American diet and had saturated fats, trans fats, just processed food, and just lots of pernicious toxins in their environment and their food supply, and they have an epiphany. They just get the fear of God in them or motivated and catalyzed to pursue the healthiest diet possible. From your perspective, how reversible is that damage?

RP: It depends on the cell types. In some cases, it’s very reversible because you’re going to get rid of that cell and you’re going to make a new cell. You can start over, so to speak, right? But in some cases, you’re talking about stem cells, cells that are around for a very long time. It’s much more difficult to reverse that damage but you can reverse it to some degree.

Your cell membranes are composed of variety of different phospholipids, lipids, and cholesterol so there’s a balance between a lot of these components. If you give yourself, for example, polyunsaturated fat like omega-3 and specific docosahexaenoic acid (DHA), which is one of the marine omega-3 fatty acids, it’s a large, large component in all cell membranes. It’s very important for the fluidity of that membrane. So, there’s a balance between cholesterol and DHA, and that’s very important for the fluidity of the membrane.

Now, why is that important? Well, that’s important because nutrients get transported into the cell, B vitamins being some of those nutrients that I’m talking about. It has been shown that as the membranes become more stiff with age, as you mentioned, Dr. Mercola... If you’re eating trans fats, for example... Trans fats, ugh, I feel horrible but...

DM: Hey, there actually is something worse. It’s cyclic aldehyde, which is what’s created when you use a substitute. Because the Food and Drug Administration (FDA), basically due to Dr. Fred Kummerow’s lawsuit... Kummerow, of course, is the initial investigator for trans fats in the ‘50s, but they banned them or they will be banned so they’re replacing them with these other oils that creates cyclic aldehydes when you heat them in high temperatures. They’re even worse than trans fats.

RP: Wait, you’re kidding me.

DM: No, I am not. Nina Teicholz, she wrote a whole book on it. I did an interview with her. It’s just like, “Oh, my gosh!” It’s like going from the frying pan into the fire.

RP: Oh, God, that’s awful. I mean the cyclic aldehydes are going to absolutely damage the cell membranes. They’re going to do almost the same as what trans fats do but with a different mechanism, totally different mechanism. You basically get this carbonyl group, eventually. That’s what these damaging aldehydes do and they cause the membrane to become stiff. They play a role in Alzheimer’s disease and cardiovascular disease. That’s awful. That is so awful. I wish you hadn’t told me that because...

DM: I just about fell on my chair when she told me that was happening. Oh my gosh! It’s just like another... It took 30, 40, or 50 years to get trans fat out of the food supply. Now, they throw something even worse and it’s going to take us another few decades to first identify the dangers, document it, and to get it banned from the industrialization. Ultimately, it goes down to - you just have to it real food.

RP: Yes, yes.

DM: It’s a simple strategy to avoid all this non-sense. But in the meantime, most people are going to do that so you have to seek these interventions to help protect the bulk of the population.

RP: Right. The problem is when you eat out. You never know what they’re giving you.
DM: Oh gosh.

RP: I’ll give you an example. Here in Berkeley, I sometimes go to this coffee shop that I like to work from. They serve salads there. Well, salads are supposed to be healthy, you know.

DM: Sure.

RP: One day I asked. I said, “You’re using olive oil, right?” They said, “No. No, it’s canola oil because olive oil is too expensive.” It’s just...

DM: It’s genetically modified organism (GMO), of course.

RP: Of course.

DM: It's been sprayed with glyphosate or Roundup, which is even worse. They could also put vegetable oils in there.

RP: Right, vegetable oil.

DM: Which is more common, you know.

RP: Right.

DM: Corn oil, which is also GMO.

RP: Exactly. There are all sorts of problems.

DM: The devil is in the details. But anyway, getting back to the mitochondrial nutrients, I was a bit surprised when you said B vitamins are clearly important. But I was thinking you might come up with ubiquinol, CoQ10, or magnesium as another co-factor. Maybe you can rate them, from your perspective as someone who’s really studied this in the lab and really devoured the literature on this. You know, you’ve got a relatively unique understanding of this and I’m sure many people would like to hear your perspective.

RP: I think that if I’m going to rate them from most important to least important in terms of taking a supplement, for example, or getting it from your food, the reason I say B vitamins, number one, is because there are so many B vitamins that are co-factors for mitochondrial enzymes to work. You need to make sure you’re getting those B vitamins like riboflavin.

DM: Do you think you need a supplement or can you get it from a high quality diet?

RP: High quality diet is always my favorite. I prefer to get as many micronutrients as I can from whole foods for a variety of reasons. One, their complex with fiber and things help with absorption. They’re in the right ratios. You’re not getting too much. The balance is right. There are other components that are probably yet to be identified that are in there. However, in addition to being... You know, you have to be very vigilant in making sure you’re eating a very broad spectrum and getting the right micronutrients.

There are a variety of polymorphisms in genes, which means basically... Polymorphism just means it’s a variation in the sequence of DNA in the gene which changes the gene function slightly. For example, there are very common polymorphisms. I have it, my husband, and my mother in-law. In fact, many people that I’ve looked at their DNA, they have polymorphisms that make them have lower levels of vitamin B12, or they can’t use folate in a certain way. Folate has many functions so they can’t use it a certain way...
DM: Which is also a B vitamin.

RP: Exactly. There are a lot of these polymorphisms. I think the reason these polymorphisms are around is if we look hard enough, there’s always a benefit. For example, if you live in a region where there was high selenium in the soil, you may over throughout time and evolution, there may be a selection for not absorbing so much selenium because too much selenium could be toxic. As a consequence, you made this whole group of people who have polymorphisms in genes that make them not absorb selenium as well. The same goes for many other micronutrients, and these are all very common polymorphisms.

I think that taking a B complex supplement is good for that reason. It’s the reason I take one, and also for the reason that as we age, we also do not get B vitamins into ourselves as readily, largely due to that part I was telling you about stiffer membranes. It changes the way B vitamins are absorbed.

DM: Interesting.

RP: Yeah. B vitamins are water soluble so they’re not stored in fat. There’s not really an upper toxicity associated with them. If anything, you’re going to pee a little bit more out. But I really think they’re beneficial. So that’s one.

Number two is magnesium. Magnesium is also very, very important for mitochondrial function. It’s important to make new mitochondria. It’s important to repair damage that’s been done to your mitochondrial DNA. Magnesium is important to repair damage that’s done to all DNA whether we’re talking about DNA in your mitochondria or DNA in your nucleus, which is your genomic DNA. It’s important for that. It’s important actually for all the enzymes that make ATP and utilize it. We’re talking about a very essential function for every single process in the body. Magnesium is very important and half the country doesn’t get enough.

DM: Maybe more.

RP: Yeah, maybe more. Magnesium is found at the center of a chlorophyll molecule and chlorophyll is what gives plants their green color, like spinach. You know, those dark green leafy vegetables. They’re high in magnesium. People just aren’t eating enough of their greens.

DM: That would solve a lot of problems if people ate more high-quality, organic, locally grown, preferably vegetables. Because they get not only magnesium but a variety of other nutrients. Many of which probably haven’t been yet discovered.

RP: Right, exactly. I think there are a lot of micronutrients that are present in plants and we haven’t figured them out yet. We don’t know exactly what they are and what they’re doing.

DM: Ideally, we go back to simply eating real food, high-quality real food.

RP: Right.

DM: That’s the core. I mean, after studying health for so many decades, it’s a relatively simple conclusion and it’s not that complicated.

RP: And once you start doing it, you feel good and you want to do it again.

DM: Yeah.

RP: That’s the thing.

[----- 40:00 -----]
DM: That’s true. I’m sure you’re reaching similar conclusions from the direction you’re pursuing also. Getting back to the nutrients, how would you rate CoQ10 or ubiquinol, which is the reduced version of CoQ10?

RP: Yes. I think the reduced version of CoQ10, which is ubiquinol, is a little better but it’s also more expensive. Am I right?

DM: Yes.

RP: Yeah. Those are both good. So this is something that we actually make inside of our cells, inside our mitochondria. It plays a very important role in mitochondrial metabolism. I think that it becomes particularly relevant for people who do have mitochondrial disorders, like it can play a huge role in helping them overcome some problems with making energy. I think that supplementation with ubiquinol, and if you take a larger dose of ubiquinone as well, is beneficial.

DM: I saw some really impressive videos from... There’s only one manufacturer of ubiquinol in the world. It’s Kaneka in Japan. They hold a patent on it. They did some internal studies on rats and gave them [ubiquinol]. They compared those that were ubiquinol-supplemented versus those who weren’t. It was just like mind boggling to see it. Unfortunately, they won’t release these videos of their research but it was so impressive.

RP: Wow

DM: Ubiquinol-supplemented ones versus the ones who weren’t.

RP: Right. Another thing... Sorry to cut you off.

DM: Sure.

RP: What you mentioned reminds me of my mentors, some of my mentor’s previous research. He’s done a lot of work on mitochondria. Him and a former post-doc of his, who’s now running or in-charge of a part of Linus Pauling Institute in Corvallis, Oregon, found that acetyl L-carnitine and alpha-lipoic acid can both reverse cognitive defects in old rats and are essentially mediated through a mitochondrial function because they’re also co-factors for mitochondrial enzymes.

Once in a while, if I remember, I supplement with alpha-lipoic acid. But actually, there is pretty substantial evidence that it is important for mitochondrial function. I probably should focus more on that.

DM: Well, and diabetes too, I think.

RP: Yeah.

DM: That’s if you have diabetes because it’s so darn easy to treat. It’s one of the easiest and most common clinical conditions that’s almost completely reversible. Of course, we’re talking about type 2 and not type 1. The sad reality is that almost all physicians don’t understand this. They rely on oral hypoglycemic [drugs] and send them to a traditional dietician to get a high-carbohydrate diet.

RP: Wow.

DM: All right, that’s good. [Are there] any other strategies to optimize mitochondrial function?

RP: Well, I think exercise is very important. When you exercise, you are forcing your mitochondria to work harder. As we talked about previously, some of the byproducts of mitochondria working harder are they’re making reactive oxygen species. As you mentioned, Dr. Mercola, these reactive oxygen species
are signaling molecules in a way. One of the functions they signal is to make more mitochondria. It’s kind of like... It’s the body’s way of going, “Oh my God, I’m using all these mitochondria.” You’re applying this work. You’re working hard so the body’s like, “What do I do? I need to make more of these mitochondria.” It’s called mitochondrial biogenesis and exercise is a fantastic way of increasing mitochondrial... making more mitochondria in your cell.

DM: Well, there are many different types of exercise. Which ones are found to be particularly useful? Is it strength training, aerobics, or high intensity?

RP: Yeah, that’s a great question. To be honest, I haven’t dove into that literature so much to really give you... I really can’t answer which one is better. I’ve seen that all of them do increase mitochondrial biogenesis. Maybe you know. Maybe you’ve read some literature on that.

DM: No, I don’t.

RP: Okay. Well, that’s something I’m going to have to look into. It’s a really good question.

DM: Well, I think whether or not it’s mitochondria but just general health, I think it’s a combination of all of them. I’m not a big fan of cardio. I did cardio for almost four decades before I realized that there are probably better strategies to use exercise to improve your health. Strength training is a darn good one because there are many different ways you can do that, but high-intensity too. So, high intensity, strength training, and some flexibility training in there, and there’s general mobility. I don’t know how it impacts mitochondrial biogenesis but...

One of the realizations I’ve had recently is that there’s a mobility requirement or movement requirement, which is independent of exercise. They’re related but they really are separate. I’m convinced. So that you can... I made the mistake for four decades or for almost 50 years. I’d be really fit, going out and exercising. I thought I was meeting my exercise requirements and I’d go and sit down for 14 hours. You just can’t do that. You’ve got to move around. Any thoughts on how... Just some simple activities like walking, moving, or gardening might have that impact on mitochondrial biogenesis but...

RP: Yeah. I don’t know about impacting mitochondrial biogenesis but I do agree with you on moving and how important that is. It’s interesting because I was recently traveling and when you’re somewhere new, you have this urge like, “If I don’t get out and see it, I’m wasting my time and money when I came to this place.” So I was walking around a lot. I felt fantastic. I mean, it was... I don’t know exactly what and why. It’s something that I’m going to look into. But it was very obvious to me that moving more... Because I’m very much in the same way because I’m always diving into science. I’m sitting and reading a lot. I love doing that, but the trade-off is I’m sitting.

DM: Well, you’re still relatively young. The younger you are, the more damage you can tolerate before it starts to accumulate and really devastate your physiology and anatomy.

RP: Yeah. The other thing that’s really interesting that you mentioned is mobility. It’s something that’s very important as you age. As you get older, one of the problems is older people become less mobile. Then they have the risk of falling and taking the hip out, and that will take you out when you’re older. I mean, that’s something that could really lead to mortality. Having this mobility and flexibility is extremely important. Not just for all these molecular processes going on inside your body but for just basically being more mobile so that you don’t end up falling and breaking a hip, and then becoming even more immobile.

DM: And not limited or restricted as you age because I encountered that. Because of all the successive sitting, I felt like I was 80 years old. I’d get up real slowly from a chair and I’d be bent over. I said, “Well, this doesn’t make any sense. I shouldn’t be feeling this way.” Once you lose that function, you realize
how important it is to maintain that as you age. I think it’s really one of the key things. It’s to be completely mobile, flexible, and have complete range of motion and pain-free.

RP: Yeah, absolutely.

DM: I mean, that’s what you want to strive for, and you can do it. If you look at these indigenous cultures that aren’t corrupted by Western influences, you can see that they lead very simple lifestyles and that’s what they’re doing. They’re moving and they’re spending a lot more time to secure their food so that’s a big part of it. But they have this continuous movement. They’re not sitting down all day and they frequently live into their 90s and 100s with very good function, very high function.

RP: Exactly. Isn’t that one of the common denominators between these cultures that do have a higher percentage of centenarians living to be a hundred? Is that it?

DM: I believe it is, yeah.

RP: Yeah. They’re out gardening. They’re walking to places. Instead of getting in their car and driving to the store, they’re out walking around and just moving a lot. I think that actually is one of the common denominators for longevity. At least that was identified by National Geographic.

DM: Sure.

RP: I forgot its name, but I think it’s called like the *Blue Zones Solution*.

DM: Sure, yes. That’s a very famous book.

RP: Yeah.

DM: It’s sad that many people, when they’re younger, don’t appreciate this. I mean, certainly most teenagers don’t, almost all teenagers, I bet. Because they feel that they’re essentially... They’re not going to be influenced by this but inevitably... I think it’s one of the things that impressed me about you is that you adopted this approach early on where you have a really significant chance of impacting your health and the health of your children because I’m sure at some point you’ll be raising some children, and that is one of the best things you can do. It’s to optimize your lifestyle so that when you do bear children, they’re healthy.

[---- 50:00 ----]

Many ancient cultures recognize this too. In fact, they would go through very rigorous strategies to have birth control so that they wouldn’t have children close together. They would have several years for the woman to recover the micronutrients that she would need to deliver a healthy child, which is not something that’s typically done in Western cultures.

RP: That’s interesting. I definitely had not heard of that. But to get back to you pointing out my interest earlier in life, I think that I’ve taken a little bit of my obsessive-compulsive... Like I get a little... And I try to use it for my benefit where I’m focusing on good things instead of bad things. But it’s true, as you’re young, you feel immortal. You feel like you’re not going to age. You’re not going to be subject to all these degenerative things that you see in your grandparents or your neighbors or whatever.

The reality is that we’re all aging, every single one of us. It’s just a matter of how well we do it, you know. There was a study that came out and was published very recently, a couple of months ago, that showed people, even though they’re the same chronological age, they age biologically at very different rates. The study cohort was around... I think it was around a hundred or so people. I don’t remember the exact number but the interesting thing was that researchers followed these humans for a long time. There
were three different time points in their life. They started when they were like 22, and then another time point when they are 32, and then another one when they were 38.

At each time point, a variety of different biomarkers were taken, like 14 different biomarkers. Telomere length was looked at, DNA damaged was looked at, cholesterol, LDL, glucose metabolism, insulin sensitivity, and on and on. So there are all these different biomarkers of health that were looked at. What was found was that even though... So if you look at someone who was 38, they biologically could look 10 years younger based on their biological markers or 10 years older. Even though they were the same age, they aged biologically at very different rates. In fact, if you took a photograph of these individuals who were in the study and you showed it to another bystander and ask them to guess their chronological age, what was interesting, and this is part of the publication, is that people would guess their biological age rather than their chronological age.

Let’s say the person looked real haggard and just looked a little worn out, even though they were 38, their age will be guessed at closer to 48 versus if someone looked really young, youthful, and healthy, their age would be guessed, even though they were 38, their age would be guessed closer to 28. That would correspond with their biological biomarkers.

DM: Yeah, I’m certain those differences would be even more extreme as you extended the age because 38 is still relatively young. That’s not even approaching middle age. If you get someone in their 50s or 60s and compare to someone in their 20s, you could theoretically have someone in 60s that looks younger and healthier than a 30 year old who may looks like he’s 65.

RP: I don’t know about you but I’m ready to adopt a biological age system.

DM: Yes, indeed.

RP: But the point is really for people to understand that the way you age, while aging is inevitable and we’re all aging, the rate of which you age, you have some control over, and the way...

DM: Not some, but enormous.

RP: Right, you do.

DM: An enormous control, which is really the empowering capacity... Because not only do you... It’s definitely nice. I don’t know anyone personally who would want to speed up the rate at which she age. But even if that’s not a motivation, you’re not going to get sick. You’re not going to die prematurely. You’re not going to have these degenerative diseases which will take you out and make you miserable or have to take drugs for them. So that’s the benefit when you optimize these things. You get the anti-aging as a benefit. It doesn’t have to be your goal. It’s an artifact of that strategy.

RP: Exactly. I mean, even if you’re not going to extend your lifespan by two decades, like you said, the quality of your life is going to be exponentially better. I mean, who wants to be immobile, in pain, and decrepit. You can’t even cook your own food and go to the grocery store. That’s a miserable... I mean, I hate saying that because some people are out there experiencing that but, you know...

DM: Some? There are tens of millions of people right now in the US who are suffering from this. That is really what motivates me and very clearly, it motivates you also. One of the things that interested me in your perspective is that it doesn’t have to be this way. That there are simple approaches that you can take and that science can help us identify what some of these strategies are and prove that there’s a simple approach that can mitigate against these events from happening.

RP: It can make you happier.
DM: Yes.

RP: Doesn’t everyone want to be happier? It breaks my heart when I see people who are disabled, elderly people who are disabled, and just miserable. You know, when you’re disabled and you’re in pain that affects your brain function. It affects your mood and behavior. It’s just so unfortunate because it’s so much that you have to be dependent.

DM: It doesn’t have to be.

RP: Yeah, and if there’s any...

DM: It doesn’t have to be.

RP: I mean, I know that my mission is in line with yours and that if there’s anything I can do, anything I can do to make sure that people my age now realize this, they don’t have to experience the miseries. They don’t have to get on drugs so they don’t have to be miserable, I’m going to do it, you know.

DM: Yeah.

RP: I’m going to do all I can.

DM: Thank you so much for joining us today. You’re a wealth of information. You have your own podcast and your own Website where you put together your thoughts. Why don’t you tell us what that is so if people want to find more of what your insights are on health and what your recommendations are? How they can find that out?

RP: I do have a Website called FoundMyFitness.com. It’s all one word. On my Website, I make a variety of videos where I sort of breakdown information in short, little tidbits for people to understand. I have a newsletter where I basically write long articles that are referenced. I don’t put any of my articles on my Website. My newsletter, you can sign up for it on FoundMyFitness.com. I also have a podcast so I have a variety...

DM: You interview experts just like I do.

RP: I’ve been doing that recently, yeah.

DM: Yeah, which is very interesting. Because of your position in the academic community, you have access to some of these incredible researchers so there’s a lot of information that you’re uncovering there. You do a great job of doing that.

RP: Thank you. Yeah, it’s very exciting. I love talking to other scientists and extracting information.

DM: You’ve got that learning as one of your passions clearly. We all appreciate that. I look forward to future conversations in which we’ll share some of that learning you’re uncovering.

RP: Thank you, Dr. Mercola. I look forward to it. It’s a pleasure having a discussion with you. I very, very much enjoyed it.

[End]