# The Underappreciated Role of Carbon Dioxide in Health
# A Special Interview With Georgi Dinkov
## By Dr. Joseph Mercola

**Dr. Joseph Mercola:**

What I initially contacted you for to discuss is carbon dioxide (CO2), which is my new passion. So interestingly, I think I sent you the bit – did you see that interview I sent you with Ray that you talked [about] previously?

**Georgi Dinkov:**

Yeah, yeah, yeah. He's mentioned carbon dioxide several times, but I think this is the only one that's exclusively about carbon dioxide.

**Dr. Joseph Mercola:**

Yeah. So, you hadn't seen that specific interview before I sent it to you?

**Georgi Dinkov:**

No, no. I've seen little clips of it. People have provided this report-

**Dr. Joseph Mercola:**

Yeah, I didn't think so because I found it on YouTube, and it just got referred to me through the recommendation algorithm. And it was only 2,000 views. 2,000 views. I said, "This is crazy. It should have 2.2 million views."

**Georgi Dinkov:**

And it was done in 2010. So, it's like this long period of time and nobody's watching it.

**Dr. Joseph Mercola:**

Yeah, it's not going at all. And we can put a link to that too, but you should – well, forget the link in case it somehow gets ignored and not put in like I said. You can just go to YouTube and type in "Ray Peat CO2" and it'll come up. It's with Bud Weiss, I think.

**Georgi Dinkov:**

Yeah.

**Dr. Joseph Mercola:**

So, watching that video – I listened to it four or five times. It was so profoundly powerful, and I knew after listening to that – because we've talked about it too, that CO2 production was important, but I didn't realize how important until I listened to him talk about it. And I won't spoil the surprise for you, but it appears to be one of the best longevity interventions that's

currently known. There really isn't anything that comes close other than maybe the diet, low linoleic acid and dying prematurely from cancer and heart disease and dementia.

But the CO2 is beyond absolutely magnificent. And virtually no one, virtually no clinician understands this. Peat was really the only guy – and he's not a clinician, he was a scientist – that really recommended it. And there are some people who are advocating it. We're going to talk about the different modalities and typically through breathing strategies. I got to warn you that most of the breathing recommendations are wrong. They actually will make you worse. You have to be really, really careful.

And I'm going to be interviewing probably one of the top breathing experts in the world, Dr. Peter Litchfield, who has a – I don't know if he has a Ph.D. in physiology. He might, but his Ph.D. is in behavioral psychology. So, he's married the concepts of understanding behavior and breathing patterns and identifying the habits that cause abnormal breathing. So, it's really important to do that. And there's so many people – and I was guilty of this.

It just really devastated my health because I was exercising actively and I was engaging in high-intensity exercises. And when I did that, I don't know how it happened, but I developed a really, really bad breathing habit that I didn't realize that I had. And I haven't done this in like 15 years, but I now understand what caused the problem is that I was overbreathing. And when you overbreathe, you blow out CO2 and you have a respiratory alkalosis, and you have really low CO2 levels and that is the devil that will kill you prematurely. It is really, really, really dangerous. So anyway, breathing's one, and we'll talk about some other modalities, but I'll let you take it from here with that introduction because it is my new passion. And I'm going to write a narrative study and have it published and review the literature, but I won't be able to do that for probably two or three months from now, which is why I wanted to be catalyzed by your insights before I start the journey to do that. But I'm going to be going really deep into this topic in the future, and this is the first time we're discussing it on the site.

**Georgi Dinkov:**

Yeah, there's a legend that – I forgot if it was Buddha or one of the other saints in the Eastern traditions, somebody asked him, "Can you summarize your – What is your discipline? What is your philosophy all about?" And the person responded, "It's learning how to breathe." Or more importantly, don't breathe too much or don't breathe too fast.

**Dr. Joseph Mercola:**

Overbreathing.

**Georgi Dinkov:**

Basically, learn to control your breath.

**Dr. Joseph Mercola:**

Yeah, yeah.

**Georgi Dinkov:**

Exactly, yeah. And it looks like these traditions have kind of – they really had their finger right on the spot on the issue. And it turns out that carbon dioxide, even though medically it's viewed mostly as a waste product of respiration, it's actually the thing that protects us from oxygen's well-known toxicity. In fact, if you speak to people who work in trauma or in the intensive care unit, when they have to revive people that are basically in shock or have suffered some kind of ischemic attack, they will tell you that the premature delivery of oxygen or delivering too much oxygen too early or without sufficient control measures – in other words, reperfusion – is actually what kills most patients after they come out of the initial shock stage. And multiple publications have been done. I think it's actually studied in medical school that the reason for that is, basically, the introduction of too much oxygen too quickly creates this massive cytokine storm and inflammatory reaction and reactive oxygen species.

And one of the reasons is that the cells are hypermetabolic. They're not producing sufficient carbon dioxide, so they're not able to utilize the oxygen properly. And there's been a lot of research, I would say, very – First of all, Asian cultures knew that carbonated water had very good health benefits. I think the Romans recommended taking baths in naturally carbonated water for all kinds of ailments, specifically arthritis, infertility, "the insanities" as they call them, [and] a number of different health problems.

Then in the Middle Ages, it was also recommended by several monks who are most of the people who are dealing with "medicine," as it was known at the time. And then more recently, in the 20th century, the Russians did a lot of research with it. To this day, you can go to [the] former Soviet Republic, there are clinics that offer CO2 baths or treatments with CO2, where you either lie in a bath when it's being filled with CO2, because it's heavier than air, so it stays in the bathtub. If you lower yourself carefully, do not disturb it, you can actually bathe in CO2 and it diffuses very easily through the skin. Not as easy as oxygen but still you will absorb a significant amount. Or you get into these big bags where you basically like go into a plastic bag up to your neck and then they fill it up with carbon dioxide and that's kind of like the same thing as-

**Dr. Joseph Mercola:**

Well, there's actually a company that makes a suit. It's essentially like a dry suit and inflates like the Michelin man. And it is essentially blocked out because carbon dioxide doesn't penetrate neoprene or rubber, so it stays in there. It's like a bag and it's safer and it doesn't escape.

**Georgi Dinkov:**

Yep. So, it diffuses through your skin and you can feel it almost immediately because you start feeling hot and that's actually a sign of vasodilation, which brings us to the first important, probably one of the most important factors of [the] cardiovascular effects of CO2, is that it's the natural vasodilator inside of the body, the endogenous one, which means it keeps your blood vessels supple. So, if basically there is some kind of a stressful event [and] the heart needs to increase its activity and delivery of blood to the tissues, the blood vessels can actually expand and accommodate that without creating more strain for the heart. Because if they don't expand, if they're not supple, if they cannot expand to accommodate the higher flow of blood, then you're going to get higher blood pressure, and also ultimately, because of the higher resistance to the

heart, you can get heart failure. In fact, I think one of the end points of untreated high blood pressure is congestive heart failure.

So, it turns out that the role of carbon dioxide, its primary mechanical role, let's put it [as] mechanical role, is actually to provide this ability of the blood vessels to be able to expand on demand. And also, with chronic treatment, it has been shown to be able to do that even in heavily calcified blood vessels. So, you can actually reverse soft tissue calcification if the treatment continues for sufficiently long periods of time.

**Dr. Joseph Mercola:**

I think you can reverse a lot of signs of aging. Damage caused from the aging process can be reversed with this.

**Georgi Dinkov:**

Yeah, almost everything. The [inaudible 00:08:20] carbon dioxide has been shown to increase its degradation in the cell. For a long time, it was considered an irreversible process.

**Dr. Joseph Mercola:**

Mm-hmm. I did not know that.

**Georgi Dinkov:**

These aging spots that we get, which actually, by the way, [is] a byproduct of iron and PUFA (polyunsaturated fatty acids), so it's best to not get them to start with, but if you do get them, carbon dioxide is one thing that can actually just help dissolve them. Tocopherols are another thing; low dose of alcohol is another thing that can actually help dissolve them.

But anyways back to carbon dioxide, so if you don't produce sufficient amount of carbon dioxide, and carbon dioxide is produced in the mitochondria exclusively in the Krebs cycle, which means if you have a mitochondrial dysfunction, if you're hypothyroid, if there's inflammation, reactive oxygen species, you name it – if [the] mitochondria is not functioning properly, you will not be producing sufficient amounts of carbon dioxide. Now, the body knows that this dysfunction can occur, and there's an emergency vasodilator, which the low levels of CO2 automatically trigger. They activate something called inducible nitric oxide synthase (iNOS). If the levels of CO2 in the blood fall below a certain level, you're going to start overproducing nitric oxide.

**Dr. Joseph Mercola:**

And just to interject here, there are three types of nitric oxide: iNOS, which you just mentioned, nNOS, neuronal-

**Georgi Dinkov:**

nNOS, eNOS, yeah.

**Dr. Joseph Mercola:**

-and endothelial, or eNOS, which tends to be the safest of them. And then I definitely want you to expand on its impact on eNOS, which is thought to be therapeutic.

**Georgi Dinkov:**

Yeah. So, for the eNOS, basically you produce nitric oxide, but it stays in the actual blood vessel. For iNOS, you produce the nitric oxide, but a lot of it also spills over into the blood. And actually, that's kind of the purpose of iNOS, because the primary purpose of nitric oxide in the body is to fight pathogens. It's a reactive nitrogen species. It's produced for only two reasons, really. Either emergency vasodilator, or if the immune system senses there is an invasion from pathogens, specifically bacteria and viruses, in which case iNOS is activated.

So, the reason iNOS is bad is because the nitric oxide does not stay localized. Basically, it's made available systemically because you want to affect all blood vessels. And that's what happens when you don't have sufficient amounts of carbon dioxide production. So, if you don't have [enough] CO2, you will have elevated NO.

But with NO, nitric oxide, you have a lot of other bad things happening. It's a highly reactive molecule. It can actually damage – it can form peroxynitrite species, which you mentioned earlier. It can actually itself damage the polyunsaturated fats in the cells, no matter where they are. Nitric oxide itself can form a covalent bond with something called cytochrome C oxidase, which is the rate limiting step of the oxidative phosphorylation.

**Dr. Joseph Mercola:**

Otherwise known as complex IV.

**Georgi Dinkov:**

Complex IV, exactly, complex IV. And the only two things that have been shown to be able to break that bond aside from – One way is to produce a new enzyme, cytochrome C oxidase, but that takes a long time and a lot of energy. So, you want to break that bond because otherwise your oxidative phosphorylation is inhibited. Methylene blue can do it, magnesium can do it, carbon dioxide can do it-

**Dr. Joseph Mercola:**

-and near infrared.

**Georgi Dinkov:**

Near infrared and some quinones, yes.

**Dr. Joseph Mercola:**

Yeah.

**Georgi Dinkov:**

And I think the primary effect of red light, just as you mentioned – the Russians did a lot of studies with it, Americans did a lot of studies with it in the early 20th century – is precisely that, it's activation of cytochrome C oxidase, if it's either blocked by something or if there are insufficient amounts of it, red light can stimulate the production of sufficient amounts of cytochrome C oxidase.

**Dr. Joseph Mercola:**

Nice.

**Georgi Dinkov:**

So basically, carbon dioxide prevents you from getting the nitric oxide, which can have the effect of pseudohypoxia because you have the oxygen in the cells, but you cannot use it because cytochrome C oxidase is blocked and they're-

**Dr. Joseph Mercola:**

So, it actually dissociates the covalent bond of nitric oxide and complex IV? Okay.

**Georgi Dinkov:**

Yeah, and very few things can block it, can break that bond. So, carbon monoxide has a very, very similar effect, but that bond is really irreversible, except methylene blue. Methylene blue can break it. And that's really the way you die from carbon monoxide, is you die from hypoxia. Oxygen is there, it’s [just] that you're not able to carry it with hemoglobin.

**Dr. Joseph Mercola:**

But carbon monoxide also binds to hemoglobin.

**Georgi Dinkov:**

Yes.

**Dr. Joseph Mercola:**

So, what is the rate limiting factor? Is it the carbon monoxide in the electron transport chain or is it the hemoglobin? Or is it both?

**Georgi Dinkov:**

I would say the hemoglobin is the first one because it immediately stops you from being able to carry oxygen to the cells. And then later on, because it also binds with cytochrome C oxidase, even the oxygen that's already there, it's being prevented from being used oxidatively for respiration to happen.

**Dr. Joseph Mercola:**

Okay.

**Georgi Dinkov:**

And methylene blue can do that with carbon monoxide in both hemoglobin and the cytochrome C oxidase platform, the enzyme. So, when you're producing sufficient amounts of carbon dioxide, not only are you getting supple blood vessels, but you're also avoiding the blockage of cytochrome C oxidase. Now, more importantly than that, the delivery of oxygen. So, let's say you breathe, you have perfectly well-functioning lungs and a capillary system and you produce sufficient amounts of hemoglobin, you're not anemic. The oxygen binds to the hemoglobin when you inhale and then this blood starts circulating. How does the blood know where to deliver the oxygen? And how does this delivery actually happen? Because the bond between oxygen and hemoglobin is relatively strong.

Well, there's something called the Bohr Effect. And basically, what the Bohr Effect says is that it's the presence of sufficient amounts of carbon dioxide that are weakening the bond between oxygen and hemoglobin. So, hemoglobin can release the oxygen when it's in the capillaries and into the peripheral tissues. So, it can release the oxygen, and then bind carbon dioxide, and then basically go the other way so you can exhale the carbon dioxide. Without sufficient amounts of carbon dioxide produced by these cells and getting excreted into the extracellular space, you will not be able to dissociate sufficient amounts of oxygen from hemoglobin.

So, this pulse oximeter the doctors really, really like using, if you actually attach it to a cadaver it will show you 100% saturation, which is what doctors love. They say, "Oh you should have high saturation." Not necessarily. You need to be somewhere in between because full saturation could also mean you're not dissociating the oxygen at all. So, you just keep circulating [it] in a futile manner into your bloodstream. And it turns out that the major factor that determines how well your tissue oxygenation will be is basically how much carbon dioxide you're producing. If you're hypermetabolic, if your mitochondria [is] not working, if you're not producing sufficient amounts of carbon dioxide, if you're actually oxidizing mostly fats, which produce less carbon dioxide per molecule, so your respiratory quotient is below 1, then you're in a state automatically of functional hypoxia because you will not be able to deliver as much oxygen to the tissues.

**Dr. Joseph Mercola:**

Yeah, let me just interrupt you for a moment because I just want to clear up something, because you said it a few times now how much carbon dioxide you're producing. And yes, that's a factor. And I'm not disputing that metabolic production should be optimized for a wide variety of reasons, one of which is CO2. But I think there are more effective strategies to raise your CO2 since I've been diving into this. One of it is the breathing, as you referenced.

**Georgi Dinkov:**

Yeah.

**Dr. Joseph Mercola:**

But the most important and then what we're going to dive into is exogenous administration, which has nothing to do with metabolic production. It's when you administer this therapeutically through a wide variety of different mechanisms. So, strategies to do that. But I just wanted to clear that up that I'm thinking that this may be the most important supplement that one can

augment to their practice. So, it doesn't mean you should ignore trying to optimize your maximum CO2 production in your mitochondria, but I just think the exogenous trumps it by a wide margin.

**Georgi Dinkov:**

Of course, because you can deliver much bigger amounts. I just wanted to point out that if you don't produce carbon dioxide, it's not at all a waste product without carbon dioxide. Another thing that says – because carbon dioxide is a Lewis acid, it's an electron withdrawing agent, even though it doesn't directly bind them like a quinone. But if you look at the structure, it's very similar to a quinone. It's a carbon atom with two carbonyl groups, and the quinone is very similar. They usually have a ring and two or more carbonyl groups. So, what happens is that Lewis acids, they drop the pH of the cell, which automatically decreases the cell's affinity for water, which means you're going to be excreting some of that extra water of the cell-

**Dr. Joseph Mercola:**

That's the exact opposite of linoleic acid and estrogen, which sucks the water in the cell.

**Georgi Dinkov:**

Exactly, which sucks the water in. And it's not a coincidence that linoleic acid has multiple double bonds. It's much more hydrophilic than the saturated fats, which lack the double bonds. And so basically, any time you have an increase of intracellular pH, you have increased affinity for water. The moment water streams in, that's already a signal for de-differentiation and mitosis or division. And if this process continues uncontrollably, we basically get cancer. So conversely, when you exclude more extracellular water. In other words, the cell becomes acidified and a little bit dehydrated, so to speak, then basically you're getting high amounts of differentiation. You're also increasing the affinity of the intracellular proteins for potassium and magnesium while decreasing their affinity for sodium and calcium. And in fact, when carbon dioxide is produced and it streams out of the cell, it draws calcium and sodium with it.

But if you're not producing sufficient amounts of carbon dioxide, which also means you're not probably producing sufficient amounts of ATP (adenosine triphosphate) because carbon dioxide and ATP go hand in hand. They're signs of good mitochondrial function. ATP has affinity for magnesium, but if you don't have sufficient amounts of ATP, you'll have more ADP (adenosine diphosphate), which is the degraded version. ADP has an affinity for calcium. So, low metabolic rate, by definition, means cellular excitotoxicity, cellular alkalinity and cellular division because of the lack of carbon dioxide and the lack of the ATP as well.

ATP always exists in the body in a complex with magnesium. So, if you're taking magnesium but not producing sufficient amounts of ATP – I think we discussed this previously – you will not become bioavailable. But the production of ATP is tied to the production of carbon dioxide. So, all of these features [of] the carbon dioxide – oh, it also increases the uptake of serotonin into the platelets, so producing sufficient amounts of carbon dioxide will lower your extracellular levels of serotonin. It also increases the uptake of histamine, a very highly inflammatory

mediator. Its transport also depends on carbon dioxide and on sodium as well, just like the serotonin-

**Dr. Joseph Mercola:**

So, what does that mean that it increases the uptake? So, uptake for-

**Georgi Dinkov:**

Into the platelets. So, if it's not in the platelets, it floats around freely and can actually go into tissues and cause inflammation.

**Dr. Joseph Mercola:**

Oh, it sequesters it?

**Georgi Dinkov:**

Yes, exactly. So, the SSRI (selective serotonin reuptake inhibitor) drugs actually inhibit the uptake and they increase the amount of extracellular serotonin. And it's considered good because "serotonin is the happy hormone." But actually, we want the opposite. And there is a drug on the market called tianeptine, which is [a] selective serotonin reuptake enhancer, [a] powerful antidepressant. You can achieve the exact same effects as this drug by increasing the production of CO2 or taking CO2 exogenously because CO2 also increases the uptake of serotonin into the platelets and into the synapse. Also, the increased delivery of CO2, whether it's endogenously produced or from the outside, it has an anti-aromatase effect, so it means you're synthesizing less estrogen. We already said you'll be synthesizing less nitric oxide. You will increase the deactivation of histamine and serotonin. And also, it's been demonstrated that when you actually increase the amounts of CO2, there is an anti-aging gene – I haven't looked much into it. It's called klotho.

**Dr. Joseph Mercola:**

Oh yeah, klotho, [inaudible 00:20:18].

**Georgi Dinkov:**

Yeah, carbon dioxide together with vitamin D are two of the well-known activators of this klotho gene.

**Dr. Joseph Mercola:**

I did not know that. That's great. Yeah, klotho is one of the – it's big in the longevity community for sure. There are studies on it.

**Georgi Dinkov:**

Yeah, so almost everything that you do, metabolically in terms of health, depends on the production of CO2. It's not a waste product. And when we breathe too fast, what happens is that

– Because the cells only can produce a certain amount of CO2 per unit of time, so every time you're breathing out carbon dioxide and taking oxygen in, but if you breathe too quickly, this kind of overwhelms the ability of the cell to produce CO2, which means that you will, at some point, be circulating a lot of oxygen. But because the CO2 production cannot keep up with the amount of CO2 you exhale, then you're going to get into a situation where you're hyperventilating, so to speak, and it really creates respiratory alkalosis because you're losing CO2.

Respiratory alkalosis means, again, edema, increase of intracellular water uptake, and it also means when the pH of the cell increases, it also means overproduction of several inflammatory mediators, including lactate. And this is a situation we're seeing inside of the cells, especially cancer cells. Cancer cells are highly alkaline and basically, they're overproducing a lot of lactate and they have a very high uptake of water. In fact, I think the word tumor is a Latin word which meant swelling. And you can actually reduce the swelling of the tumor to a tremendous degree simply by either increasing delivery of CO2 around the tumor if it's on the surface or increasing uptake of CO2 through either a CO2 bath or if you take drugs that increase the levels of CO2 in the blood, such as the drugs known as carbonic anhydrase inhibitors, which decrease the degradation of CO2, so over time you're going to build up more CO2 in the blood, so you will acidify the body.

**Dr. Joseph Mercola:**

Yes. And that would be acetazolamide or Diamox?

**Georgi Dinkov:**

Yes, exactly. So, there are several of them. Thiamine recently was discovered to be as potent as acetazolamide as a carbonic anhydrase inhibitor, vitamin B1. So, really, it has an anti-fibrotic effect. In fact, there's like an old prescription from the Middle Ages – that book you sent me talks about it – basically, they had this magical spring that they thought was infused with the spirit of God. And people with fibrotic disease would go in there and their scars would disappear if they bathe their legs or whatever other limbs or even the body, they bathe in that spring.

**Dr. Joseph Mercola:**

So, it has to be anti-serotonin?

**Georgi Dinkov:**

Yes, exactly-

**Dr. Joseph Mercola:**

[crosstalk 00:22:59] fibrosis.

**Georgi Dinkov:**-

-which we kind of discussed here. It increases the deactivation of serotonin, but more importantly, even after the collagen has formed, the scar has formed, which is what fibrosis is

really, over-collagenization, it's able to actually manage to dissolve this fibro scar tissue, probably by increasing its innervation. Scar tissue is, even though it's alive, it doesn't have a lot of nerves on it.

A lot of people with scars, if they touch them, they feel numb. In fact, many people can cut their scar tissue and not feel much in terms of pain simply because that tissue is denervated. And the denervation process is one of the precursors to cancer. The central nervous system controls the cancerization. If there's no nerves there, at some point, cancer will probably develop. It's not a coincidence that fibrosis is a precursor state to cancer.

**Dr. Joseph Mercola:**

So, you believe the mechanism of how it addresses the scar tissue is increasing oxygen delivery by vasodilation [inaudible 00:23:58]?

**Georgi Dinkov:**

Oxygen delivery and also nerve growth. There's something called brain derived neurotrophic factor (BDNF)-

**Dr. Joseph Mercola:**

Otherwise known as [inaudible 00:24:04]-

**Georgi Dinkov:**

It's been shown that inhaling carbon dioxide increases that molecule, and it's been shown to increase innervation not only in the central nervous system-

**Dr. Joseph Mercola:**

The peripheral?

**Georgi Dinkov:**

-but also peripherally. Yeah.

**Dr. Joseph Mercola:**

Oh wow. So, it's a peripheral activation. BDNF. BDNF is improperly named. It should be CDNF, central – CNSB.

**Georgi Dinkov:**

Or PDNF, peripheral derived neurotrophic factor-

**Dr. Joseph Mercola**

Well, brain implies central, you know. Yeah.

**Georgi Dinkov:**

Yeah.

**Dr. Joseph Mercola**

But it's a nervous system, central, general.

**Georgi Dinkov:**

Yeah, it's a nervous system and it increases its activity – It calms it down too because of the decalcification, by taking calcium outside of the cell and, of course, neurons of cells too. By taking excess calcium outside of the cell, that's what has the calming effect. And I think there was a carbon dioxide therapy back in like maybe a couple of decades ago for epilepsy. It was actually, like, if you have like susceptibility to seizures-

**Dr. Joseph Mercola:**

It should be instead of ketosis.

**Georgi Dinkov:**

Yeah [inaudible 00:24:57].

**Dr. Joseph Mercola:**

That's for darn sure.

**Georgi Dinkov:**

And the test for susceptibility to seizures was hyperventilating. They'll ask you to breathe through your mouth-

**Dr. Joseph Mercola:**

Yeah, yeah.

**Georgi Dinkov:**

-very quickly for maybe 30 seconds, and if you start to seize up or get jittery, they'll tell you to stop and say, “Okay, you have insufficient amount of carbon dioxide in your body.”

**Dr. Joseph Mercola:**

That should be a clue. That should be a clue, but most physicians just never got it. So I was fortunate enough to acquire a copy of the book written in 1905 by Dr. Rose, who was a pretty prominent physician at the time. He had published a lot and was active in the academic area, and he compiled a list of conditions and treatments and did a pretty nice summary. And it's interesting, I'm sure you noticed it too when you're reading it, the language is completely different. It's basically almost 150 years old, especially when it comes to medical jargon. The terms were so different that they were using back then. It's a gradual shift and you never notice it until you abruptly see it in an older document like that. But it was fascinating and it just further reinforced the value.

And you had mentioned that these mineral springs – well, these mineral springs did not have the breath of God. Maybe if you consider CO2 the breath of God, but it was really high in carbon dioxide concentrations. And that's why people continue to go there because they got value from the CO2. So, it's been used therapeutically for centuries. It wasn't until like the 1850s or so where they were able to understand how to use chemicals to generate CO2 gas. This was before they had cylinders of it like we do today and actually provide carbon dioxide therapy to the tissues. Did you see the illustrations there where they put in a glass bottle, put in like tartaric acid and baking soda and water, and they generate the gas and the gas gets generated and delivers into the tissue? So, why don't-

**Georgi Dinkov:**

Or heat up limestone or something-

**Dr. Joseph Mercola:**

Yeah, yeah.

**Georgi Dinkov:**

-with acid, I think that was the other method.

**Dr. Joseph Mercola:**

Yeah, actually later in the book, he actually gives the doses and everything too, which is pretty good if we have the global reset that just decimates and destroys all our resources. You can basically make it yourself with baking soda and some type of acid. So why don't you just give us your view of the book? I suspect, did you finish it yet?

**Georgi Dinkov:**

I haven't finished the whole book, but I saw the – I mean, I read the intro and then I looked at all the conditions that are there and basically, it spans all the physiological including the mental conditions as well. The book doesn't go into great detail, but I found several studies showing that a combination of acetazolamide and thiamine, vitamin B1, achieved 70% cure for the "insanities," which they used to call them back in the 1960s.

**Dr. Joseph Mercola:**

Or hysteria. Hysteria, because obviously it was due to women's uterus.

**Georgi Dinkov:**

Yes, but cures. Cures, not remissions. And there were mental institutions at the time. All these people were hospitalized, some of them for life. So, in order for them to get released from the hospital, they must have truly achieved a pretty significant and sustained modern [inaudible 00:27:58] remission, because nothing is curable in modern medicine. And these people, just by raising their CO2 levels, these people managed to cure some of the really terrible insanities, something that will probably pass as schizophrenia or psychosis these days, or even dementias.

There was another study that I found that basically, if you increase – if you get people to breathe in a, not in a paper, but in a container, that will gradually increase the concentration of carbon dioxide, you can actually get people from moderate to severe Alzheimer's disease back to a situation where they can recognize their relatives. Similar studies have been demonstrated with lithium, microdosing lithium back in the early 20th century. Well, actually, lithium was part of the spring water in many of the cities around the United States. It only later got removed, so that the FDA can sell it as a drug or the companies can sell it as a drug. But lithium has a very strong stimulating effect on the production of carbon dioxide. So, to me, that's the major explanation, the main explanation behind lithium's benefits.

And to this day, lithium is the gold standard drug for treating bipolar disorder and many of the other situations that involve mania. And mania is really another euphemism for excited toxicity into the nervous system, which is what CO2 reverses. So yeah, basically, I think they mentioned dysentery. They mentioned fistulas. They mentioned fibrotic conditions of the digestive tract-

**Dr. Joseph Mercola:**

Whooping cough.

**Georgi Dinkov:**

Whooping cough. I think there was even a mention of a case of tuberculosis. They also mentioned a case of – what do they call it – rhinitis, which I guess you consider an allergic condition. However, just as I mentioned, since CO2 increases the reuptake of histamine, you would expect it to have an antihistamine effect, which kind of corroborates with that finding. So really, every condition you can think of, both physiological and mental, can be remediated and in many cases cured by increasing endogenous CO2 production, decreasing its degradation, which is what the carbonic anhydrase inhibitors do, and/or taking extra CO2 exogenously. And of course, the most important thing, breathe through your nose, not through your mouth and not too often.

**Dr. Joseph Mercola:**

Well, it's very rare where I want to revise what you just said, but this is one of those rare conditions. So yes, nasal breathing is far superior and it is the goal, but I wanted to let you know and everyone know that you can easily, easily overbreathe through your nose and many, many people do it. So, just breathing through your nose is not sufficient. It has to be [inaudible 00:30:34].

**Georgi Dinkov:**

That's why I said, not too often, not too often.

**Dr. Joseph Mercola:**

Yeah, I know, but you've got to be careful. So, the problem is you get the psychologically initiated and persistent habits. It's a habit. It's basically [a] habit. And it's a pathological habit where you overbreathe. And that's the key thing is you overbreathing. In fact, Peter [Litchfield]

discusses in his training modules how the most common reason for ambulance rides in New York City – it's like 60%, and that's a lot. I mean, obviously the majority. And people don't jump into an ambulance unless they think they're going to die because most of them are aware that there's a huge bill for that and it probably could result in medical bankruptcy to go and jump into an ambulance. So, they only do it if it's serious, and the majority of those people have to do because they were overbreathing.

Almost all the panic attacks are due to overbreathing. Migraines, this vascular constriction of the brain. You can eliminate the migraine, and I did not know this until just recently. I used to use magnesium and that does have some pretty potent, effective vasodilatory capacity, but not as effective as CO2. So, you can eliminate all these vascular headaches and by just – clearly, you want the metabolic production in the mitochondria, but you want to minimize the loss, the removal of carbon dioxide from your body through the breathing, overbreathing, which can result in – some of the most common symptoms would be a headache or dizziness or air hunger.

And the problem with these breathing habits is to get into a vicious cycle where you just get trapped and you can't get out. And your solution psychologically is to continue to breathe more. And it just makes it worse and worse until you pass out. I mean, it really is a terrible condition. You really feel like you're dying. And that's what the panic disorder is from, this overbreathing that is a result of usually some type of trauma or a fact that caused this bad habit. But fortunately, it's fixable, and there are devices called capnometers, which measure the CO2 level in your breath and they can be really helpful for identifying, diagnosing and developing a protocol to help behaviorally eliminate that. So, that's an important component, but it's not the most important. And the reason I got so excited is because I just recently learned this, that – and it was, as I said earlier, catalyzed by the Ray Peat CO2 lecture that he gave almost 15 years ago – is that its use exogenously is probably the key ticket. And there's a number of different ways I want to go over.

Probably the most common and palatable way for most people is going to be to breathe it in. Some people are doing this now, you can do a soda stream or a variety of ways. You can drink it too, you can eat it, drink it through water. Actually, [with] carbonated water, you're going to get some CO2, but I think it's relatively small.

**Georgi Dinkov:**

Are you familiar with Mr. Muslimov and the National Geographic movie that was made about him?

**Dr. Joseph Mercola:**

No, no.

**Georgi Dinkov:**

He lived to the age of 168.

**Dr. Joseph Mercola:**

Really?

**Georgi Dinkov:**

Confirmed, yep. They did a movie with him in the 1970s. He lived in the former Soviet Republic of Azerbaijan. He got married at the age of 142, had a kid at the age of 150. And the only reason he died at the age of 168 is because he fell off his horse-

**Dr. Joseph Mercola:**

Oh, jeez.

**Georgi Dinkov:**

-and I think broke his hip or something and just didn't recover from that.

**Dr. Joseph Mercola:**

Yeah, well, I know it's possible, but I'm absolutely confident that to do that, you have to be biologically optimized

**Georgi Dinkov:**

Yeah, definitely.

**Dr. Joseph Mercola:**

And that most all of our conversations, and I would definitely review the previous ones, really focus on this because you are a giant in helping people understand the biology of why this is so important in all the details. So, biological optimization with the mitochondrial energy production is key. But this is kind of next level. So, that doesn't dismiss the fact that you need to optimize mitochondrial cellular energy production.

That's absolutely imperative, but the next level that takes it – because we're going to – the general principle is that life on earth started a long time ago, and primitive life and biology on this planet was used to high CO2 levels. I mean really high. Right now, it's 0.4%, less than one-half of 1% is the level of CO2 in the atmosphere, which is pretty tiny. I mean, in the Ray Peat CO2 presentation, he talked about the naked mole rat, which is what really catalyzed my interest, which is an animal that lives up to 30 years long, which is exponentially longer than a conventional lab rat, which is 2 or 3 years.

**Georgi Dinkov:**

It's 99.9% genetically identical to the common rat but has a ridiculously longer lifespan-

**Dr. Joseph Mercola:**

Yeah. And so, his speculation-

**Georgi Dinkov:**

So, it's not genetics.

**Dr. Joseph Mercola:**

-I'm sure you saw the video is that this rat digs a hole and then covers up the opening to the hole. So as a result, the CO2 levels rise pretty dramatically where it's like 5% or 6% – now this naked mole rat is a mammal and we are mammals too. Now, clearly, we're not a rat, and I'm not suggesting any way, shape or form we are, but there are many similarities in metabolic physiology. And this to me was just a shocking illustration that there might be some magic with CO2 and I'm-

**Georgi Dinkov:**

And bats too. Bats are the same.

**Dr. Joseph Mercola:**

Oh bats, yeah, that is the other illustration. Thank you for reminding about it. Yeah, bats do the same thing even though they shouldn't have a long lifespan because of such a high metabolic rate and rapid heart rate.

**Georgi Dinkov:**

It's basically a mouse with wings, so it should live as long as a common mouse-

**Dr. Joseph Mercola:**

Yeah, yeah.

**Georgi Dinkov:**

-which is 2 years tops, but it lives 30 to 40 years in the caves.

**Dr. Joseph Mercola:**

Yeah, yeah, because in the caves, the CO2 level is high. So, that is the biological clue that there's some magic here, and I don't think anyone understands precisely other than the general principles you brilliantly outlined and identified, some of which I wasn't aware of and that's why I had you on because I wanted to get the basics from you, but there's probably some other things going on too that we still don't understand that really catalyze our biology to radically improve our quality of life.

So, I'm committed to doing this every day. And you can travel with these bags. You can fill up a bag. You don't have to carry around a 20-pound container, but you can probably do smaller cylinders too, that you can travel with if you needed to. But it's really magic. And there are companies that sell regulators that you can use on the CO2 tanks where you can breathe them and that definitely – it's actually better than jumping in a bag and getting the CO2 or going into one of these body suits and doing it. It's actually superior to breathe it, but beyond breathing it would be the rectal insufflation.

Now interestingly, I developed some cataracts because of over-aggressive longevity interventions, which was related to hyperbaric chamber use at too high pressures. So, I have

some strong evidence that I'm thinking just using the carbon dioxide flowing out of the bag onto the eyes will help reverse that.

**Georgi Dinkov:**

Niacinamide eye drops can do it. Recent study came out-

**Dr. Joseph Mercola:**

Well, they're – Niacinamide? I am using that too.

**Georgi Dinkov:**

Yep. And progesterone eye drops, believe it or not.

**Dr. Joseph Mercola:**

Really?

**Georgi Dinkov:**

Yeah, yeah, recent studies-

**Dr. Joseph Mercola:**

Can you send me those? Send me those studies.

**Georgi Dinkov:**

Yeah, I'll send those to you. Yeah.

**Dr. Joseph Mercola:**

I did not realize that. And niacinamide is still – what, about 2% or 4%?

**Georgi Dinkov:**

Yeah, something like that, 2% or 4% in just saline water and then you just put in drops.

**Dr. Joseph Mercola:**

Yeah. Yeah, it's really good. I was using niacinamide. I haven't used them, but I forgot about the niacinamide eye drops. That's a good one. I should start again. Now, ostensibly, N-acetylcarnosine (NAC) can do that too, but I think those studies were flawed and it doesn't work. I got to find-

**Georgi Dinkov:**

Interestingly enough, the niacinamide study demonstrated that the reason for dry eye and cataracts is decreased production of pregnenolone, testosterone and DHEA (dehydroepiandrosterone) locally in the eye. And then when you supply niacinamide, it gets converted to NAD+ (nicotinamide adenine dinucleotide), which is the cofactor for many of the downstream enzymatic – So, you restore local stereognosis of the protective steroids. And they

claim that basically the problem is bioenergetic, but the direct cause is the loss of the protective steroids.

**Dr. Joseph Mercola:**

Geez, I definitely want to go through that study. So, how would you administer progesterone in the eye?

**Georgi Dinkov:**

That's a little bit difficult because it's a lipophilic molecule-

**Dr. Joseph Mercola:**

Yeah, yeah, for sure. You got sterility issues.

**Georgi Dinkov:**

I guess you can try to look if there is a pregnenolone sulfate, slightly more water-soluble. That can be one way. Another way is you don't have to administer directly into the eye-

**Dr. Joseph Mercola:**

You could do it on the eyelid.

**Georgi Dinkov:**

Exactly. Eyelid or on the temples, anywhere here on the face or the scalp because the trigeminal nerve ultimately will affect the eye and carry it there as well.

**Dr. Joseph Mercola:**

Okay, yeah, because there's no way – It's hard to imagine putting that in the eye. I mean, I'm-

**Georgi Dinkov:**

No, no, tocopherol and oils, they're going to irritate the eye if you put them. Too viscous.

**Dr. Joseph Mercola:**

Yeah, that would not be good. That would not be good [inaudible 00:42:40] for sure. Wow. I'm going to give that a try. I'm going to figure that out. I'm going to figure it out by tomorrow for sure.

**Georgi Dinkov:**

Yeah, I think for a progesterone that they did some kind of a cyclodextrin solution, which is just make it-

**Dr. Joseph Mercola:**

Yes, cyclodextrin are dangerous though, aren't they?

**Georgi Dinkov:**

Yeah, yeah, they are.

**Dr. Joseph Mercola:**

Yeah, yeah.

**Georgi Dinkov:**

And they're very inflammatory themselves. So, I thought, "Wow, what a way to reverse the beneficial effects." Maybe the effects will be even – because the effects were even good with that solution I thought without the cyclodextrin would have been even better.

**Dr. Joseph Mercola:**

Yeah, yeah, you don't want cyclodextrins. Now, I was at a biohacking event this year and one of the vendors had a sub-nano glutathione, which – because glutathione is normally about 80 nanometers. This was like under 1 nanometer and they did it with cyclodextrin, and I said, "Yeah, I don't think it's a good idea."

**Georgi Dinkov:**

Yep. Yep.

**Dr. Joseph Mercola:**

Wow. Where are we at? Oh, okay. Yeah. I probably need to shift out, I think, close to it. Maybe we could summarize these things. We're not going to have enough time. I'm going to have to have you back to go over the quinones as a substitute for methylene blue, but I probably should just summarize this and maybe you can comment on it quickly. So anyway, let me just – I'm going to be interviewing [Dr.] Peter Litchfield soon to at least give everyone the next level of how to understand how the breathing works and how you can actually get consultants to help you process this because it's really hard to figure out yourself. And that's coming soon within the next month or two.

But I was giving a presentation at an event that was targeting parents of autistic children. And someone – I didn't actually mention it in my lecture because I've become less fond of methylene blue. And someone asked a question after my presentation and asked about methylene blue and I mentioned it. Then one of the other presenters came to me after my presentation and pointed out – she was – I'm actually interviewing her in January. Sabina is her first name and I forget her last name, but she's a gastroenterologist from California and pointed out that in her experience – she really studies deeply the human microbiome and found out that methylene – because you probably don't know this, that's why I wanted to share it with you. I certainly didn't know it – that in her studies, the methylene blue just destroys bifidobacteria in the gut. Gone.

**Georgi Dinkov:**

Oh wow.

**Dr. Joseph Mercola:**

And she didn't come up to me in a disparaging way. She was just trying to give me information, which is great. I love it in that context. And actually, I was not reluctant to consider it, because there are some cases that methylene blue will save your life. There's no question about it. It is a useful tool in the bucket, but it's not as useful as I thought previously. And so, I've shifted my position on methylene blue . I still use it in relatively small amounts. I take maybe 2 milligrams three times a week before I do my sauna.

**Georgi Dinkov:**

That actually happens to be the amount that achieves concentrations inside the cell that are shown to reverse aging. Anything more than that, you're probably going to inhibit monoamine oxidase type A.

**Dr. Joseph Mercola:**

Oh, how about that? I independently came up with the Georgi dose.

**Georgi Dinkov:**

It's not Georgi, but the people that did the anti-aging research.

**Dr. Joseph Mercola:**

Yeah, well, you found it. That's the key.

**Georgi Dinkov:**

Yes.

**Dr. Joseph Mercola:**

It's just like using a search engine. You know, if the search engine didn't exist, you'd never find it. So, thank God we have the search engine. You're the search engine for these useful studies. So, thank you.

**Georgi Dinkov:**

100 nanomoles per liter is the optimal. So nanomolar per liter, you need very low doses.

**Dr. Joseph Mercola:**

Okay, so the dose is 2 milligrams, but what's the frequency? Because the half-life is pretty high, so is it like every other day or is it every day?

**Georgi Dinkov:**

I think a milligram daily, 1 milligram tops daily would achieve that concentration. When people asked Dr. Peat, he said micrograms per day he thought would be even better. Really, the concern is – without knowing the bifidobacteria effect, the concern is that even a milligram doses, maybe like 10 or 15 [milligram], it's going to start to inhibit monoamine oxidase type A, which

preferentially metabolizes serotonin so you can get like a serotonin syndrome. And there are published cases of people usually on SSRI drugs-

**Dr. Joseph Mercola:**

[inaudible 00:46:54], yeah.

**Georgi Dinkov:**

-but they took a low dose methylene blue with the SSRI drug and ended up in the hospital with serotonin syndrome. So, we know the danger is there. And the different quinones, so the methylene blue and the benzoquinones, such as coenzyme Q10, seem to preferentially inhibit monoamine oxidase type A. The naphthoquinone, such as vitamin K, and even the tetracycline antibiotics preferentially inhibit monoamine oxidase type B.

So, they're actually decreasing the deactivation of dopamine. And monoamine oxidase type B inhibitors are one of the earliest anti-aging drugs. There's a drug called selegiline, also known as Deprenyl. And back in the ‘60s and ‘70s, it was all the rage among the rich people, in Hollywood especially, as the first kind of a widespread anti-aging therapy. To this day it's used. So, we know that they have that inhibiting dopamine breakdown as an anti-aging effect. But methylene blue actually, unfortunately – and the dosage is probably different for different person, depending on how hypothyroid[ic] they are – you can get a severe buildup of serotonin even by low milligram doses daily. So, anything more than a milligram I would not use daily.

**Dr. Joseph Mercola:**

Yeah, so 2 milligrams three times a week would qualify too, I would think.

**Georgi Dinkov:**

It's just the same. It comes out to 1 milligram daily, right?

**Dr. Joseph Mercola:**

Actually a little bit less, but yeah. Yeah. So that's good. That's really good, actually. I'm very pleased with that. And then you also recommended the methylene blue mouthwash and was it 5 or 6 milligrams in a liter of water?

**Georgi Dinkov:**

So, the same concentration they used to sterilize the fish tanks, and from what I understood it’s basically about 5 to 6 milligrams per liter. I think the dosage that they used was per gallon, so it was like 20 milligrams per gallon. But a gallon is almost 4 liters, so you're getting about 5 to 6 milligrams per liter.

**Dr. Joseph Mercola:**

Okay, yeah, anything higher is not – more is not better. It's the Goldilocks dose, is what you want.

**Georgi Dinkov:**

Yeah.

**Dr. Joseph Mercola:**

And so many of us, and I'm absolutely guilty of this – "More is better. If a little exercise is good, killing it is going to be great." No, it's going to kill you prematurely if you do too much. We just did a – I just interviewed a cardiologist from Mayo Clinic who published a really landmark study, I don't know if you saw it, about exercise and how any resistance training done intensely for over two hours a week, you're going to actually be better off if you were a couch potato because you will increase your death rate.

**Georgi Dinkov:**

Yeah, yeah. Remember we discussed this.

**Dr. Joseph Mercola:**

Yeah.

**Georgi Dinkov:**

Especially because there's a heavy eccentric portion in the weight lifting, yeah.

**Dr. Joseph Mercola:**

Oh, yeah, yeah. Yeah. But I think it was even beyond that. I just think it just pushes you too hard. You know, it's a balance-

**Georgi Dinkov:**

Yeah.

**Dr. Joseph Mercola:**

And the best exercise is walking. Apparently, this is – yeah.

**Georgi Dinkov:**

Yep, yep. **Dr. Joseph Mercola:**

So, you know, it's movement.

**Georgi Dinkov:**

All the centenarians without exceptions were never active athletes. And all of them, I think, were gardeners. And many of them smoked. Now, I don't recommend picking up smoking, but I just want to say that it's definitely not the phenotype that most people would imagine, these jacked, lean people that [are] lifting weights all day six days a week or whatnot. Ray Peat used to quote William Blake who said, "You never know what's enough until you experience what's more than enough."

**Dr. Joseph Mercola:**

There is some value to that. Puts perspective on life, that's for sure. So just finishing up, so you mentioned the benzoquinones like CoQ10 and vitamin K2. And there's two forms of K2, one is MK7, the other is MK4. MK4 probably is better overall, but compliance sucks because you got to take it three times a day, four times a day-

**Georgi Dinkov:**

Yeah.

**Dr. Joseph Mercola:**

-whereas MK7 has a long half-life and once a day is sufficient. But those – go ahead.

**Georgi Dinkov:**

So, the only difference is the length of the side chain. So basically, the vitamin K2 MK7 has a longer lipophilic chain. So, it basically stays in the system longer. However, the actual active cofactor for gamma-glutamyl carboxylase and the carboxylation of osteocalcin and the carboxylation of many other proteins, which is the attachment of carbon dioxide to many of these proteins-

**Dr. Joseph Mercola:**

I was going to say this, that's what it's doing. It's putting CO2. So, wouldn't it make sense that if you had more CO2 in your tissues, that'd be more helpful?

**Georgi Dinkov:**

Yep. It's such an important thing. Many of the actual-

**Dr. Joseph Mercola:**

If that [inaudible 00:51:06]. I did not remember that's how K2 works. It helps facilitate the carboxylation.

**Georgi Dinkov:**

So, your insulin – many of the peptide hormones are not actually active until they get carboxylated. So, if we don't have carbon dioxide, they will not be active. But even if we have carbon dioxide without vitamin K, they will not get carboxylated.

**Dr. Joseph Mercola:**

K2, K2.

**Georgi Dinkov:**

K2, and specifically MK4, is the cofactor, the direct cofactor that our body uses. So, there's some research that suggests that while MK7 is active as a quinone, it can help if there's a blockage in the electron transport chain somewhere, it's not the direct cofactor for the carboxylation. It gets

converted back into the slightly shorter chain version known as MK4. Same thing for K1. K1, phylloquinone, basically, it has a hemostatic effect. It will stop excessive bleeding. It will act as a quinone, but for the carboxylation, it's only MK4. So maybe, ideally, is to use a combination of all three, depending on-

**Dr. Joseph Mercola:**

Yeah.

**Georgi Dinkov:**

-of the price or a combination of MK4 and MK7 I think will be-

**Dr. Joseph Mercola:**

MK4 is a lot less expensive too. The big challenge with it is the compliance because it's not easy to get.

**Georgi Dinkov:**

The compliance, yeah.

**Dr. Joseph Mercola:**

And what's the half-life? Do you have to take it three times a day or maybe four is even better?

**Georgi Dinkov:**

So, the half-life can be misleading. You want to measure half-life in tissues, which has not been done with MK4. They've only measured half-life in blood. And then we know that for MK7, it's longer. But some studies have said, "Well, maybe the reason MK7 has a longer half-life in blood is because it's not directly usable to the tissues." They need to convert it back to MK4. So, it circulates around until some of the side chain gets cleaved and it becomes MK4. But MK4 is directly usable and very quickly disappears from blood in a matter of, I think, three or four hours is the half-life.

**Dr. Joseph Mercola:**

That's what I thought. Yeah, yeah.

**Georgi Dinkov:**

Yeah.

**Dr. Joseph Mercola:**

Somewhat like T3.

**Georgi Dinkov:**

But that may actually be a good sign, which means – it hasn't been investigated, but it could mean also [that] tissues have a very high uptake of MK4, just like pregnenolone and DHEA. So,

it rapidly disappears from the blood, but it's actually in the tissues doing what it's supposed to be doing.

**Dr. Joseph Mercola:**

Oh, darn. So, it's the tissue levels. I mean, you remind me every time of the basics. It's the tissue levels. [In] the last conversation on estrogen, you made that point really clear that you can – all these clinicians are measuring in the blood and the estrogen level's low. "Oh, you need it." No, it's not in the blood, it's in the tissues.

**Georgi Dinkov:**

Yeah, that's where it actually acts, right?

**Dr. Joseph Mercola**

Yeah, yeah.

**Georgi Dinkov:**

All you see into the blood is a transport mechanism and the health of the gland that's producing it. So, estradiol in the blood is mostly of ovarian origin. Yes, it's low in menopause because the ovaries are failing. That does not mean it's low in the tissues because the tissues can produce it themselves.

**Dr. Joseph Mercola:**

Yeah, yeah. So, do you think that's similar with K2 MK4? That the tissue levels – that the MK4 migrates into the tissues and stays there and stays there longer?

**Georgi Dinkov:**

Yes, because I saw some studies with humans that basically showed that even 5 milligrams of MK4 taken once daily was sufficient to increase to the maximum amount possible the carboxylation of osteocalcin, even though basically the blood levels disappear very quickly because with 5 milligrams within an hour it's gone.

**Dr. Joseph Mercola:**

Yeah, yeah, yeah.

**Georgi Dinkov:**

You need about 30 to 45 milligrams to actually get that big peak in the area on the curve. So you need about tens of milligrams to produce the three-to-four-hour half-life. Lower doses appear even more quickly. So, they thought that a lower dose will not be sufficient. But they found out that anything over 1 milligram and up to 5 milligram was maximum stimulating for the carboxylation of osteocalcin, which should not be happening if the effects were very short-lived.

**Dr. Joseph Mercola:**

Yeah, yeah. So, your suspicion is it does stay in tissues longer?

**Georgi Dinkov:**

It stays in tissues longer, especially in the liver. One of the reasons Dr. Peat recommended eating liver is that most of [the] fat-soluble vitamins are there. So, if you're taking vitamin K[2] [MK]4, it could very well be stored in tissue, specifically in the liver, and then the liver releases it as needed. There is a very big reservoir of vitamin K in the liver, which is why originally a good source of vitamin K was goose liver pate. And I think that they were even raised for that specific reason, to provide-

**Dr. Joseph Mercola:**

Yeah.

**Georgi Dinkov:**

-vitamin K with the X factor of Western Price, I think. Didn't he say that some cultures specifically ate – like we're raising the ghee specifically to fatten them up.

**Dr. Joseph Mercola:**

Yeah, yeah, the extra X Factor was K2 for sure.

**Georgi Dinkov:**

Yeah.

**Dr. Joseph Mercola:**

I don't think he differentiated because I don't think the science was known at that time between MK 4 and MK7. But now it is MK4-

**Georgi Dinkov:**

But they were eating liver-

**Dr. Joseph Mercola:**

-MK7 is a bacterial metabolite.

**Georgi Dinkov:**

And they found that eating liver even once a week, I think, was sufficient to produce benefits on bones and other tissues that vitamin K is known to help protect. You don't have to eat liver every day, right?

**Dr. Joseph Mercola:**

Yeah, sure.

**Georgi Dinkov:**

So if you have a very short half-life, you shouldn't want [it], but once a week or once every two weeks is sufficient to get those benefits, which suggests that it stays in your tissues.

**Dr. Joseph Mercola:**

Didn't the Japanese researchers do studies showing that MK4 radically improved reversal of osteoporosis?

**Georgi Dinkov:**

Reversal. In fact, it's an approved drug called Glakay, G-L-A-K-A-Y. You cannot get it over the counter in Japan. It's an osteoporosis drug for prevention and treatment. And the dosage is 45 milligrams daily. And you take it once a day.

**Dr. Joseph Mercola:**

Mm-hmm. Yeah, I think that's what – was your best guess? I'm thinking maybe 30 milligrams three times a day might be optimal. I know you can get by with less, but what do you think?

**Georgi Dinkov:**

I think [it] depends on the reason. If it's strictly for bone health, there's [a] human study that said that 1 milligram is the minimum of MK4, [they] specifically looked at MK4. Anything less than 1 milligram, they did not see carboxylation of osteocalcin, which is the required cofactor for creation of new bone tissue. Up to 5 [milligram], they saw increasing as you exponentially increase in carboxylation. And after 5 milligrams, there was a plateau. But I think they only tested 10 milligrams over the 5 milligrams. I don't think they went all the way up to 45 [milligrams].

The Japanese studies did dose-response relationships and found out that you can take much higher doses up to 45 milligrams three times daily. And there were additional benefits on insulin sensitivity and blood glucose, but the benefits for – which means the metabolic effects are still there. In fact, you can get more of them with more, but the benefits for bones plateaued around 45 milligrams daily.

**Dr. Joseph Mercola:**

Yeah, but it's nice to have strong bones. Who doesn't want strong bones? Who just wants to die from a hip fracture when they get old?

**Georgi Dinkov:**

Of course, yeah. But these are people with osteoporosis. For healthy people, apparently, 5 milligrams daily apparently was enough.

**Dr. Joseph Mercola:**

Yeah, but the primary reason I'm advocating this as a substitute for methylene blue in the mitochondria to absolutely reduce reductive stress and optimize cellular energy production in the form of ATP. So maybe 30 milligrams three times a day might be the sweet spot. Yeah.

**Georgi Dinkov:**

That's great. That's great. In fact, it has a very potent anti-estrogenic effect.

**Dr. Joseph Mercola:**

Yeah. Yeah.

**Georgi Dinkov:**

Yes. My group did a study with yeast and there are these things called the YES and the YAS assays, the androgen assay and the estrogenic assay. Vitamin K1, K2, specifically MK4, MK7 but weaker, and K3, also known as menadione – I do not recommend that form, but it is used as a cheap version of vitamin K in some countries – they were all anti-estrogenic in the yeast assay. They were pretty potent anti-estrogenic. Stronger than tamoxifen, which of course, it's partially estrogenic, but it was the reference compound. They were all stronger than tamoxifen. And the concentration that we used would require about 10 milligrams at least twice daily to achieve.

**Dr. Joseph Mercola:**

Okay, well, this has been great. We're able to hit most of the highlights at least in there. That's great. So, I want to thank you. You're amazing. The amazing hydrant comes through again, providing us with just really valuable insights that – I mean, you could be a full-time researcher and do this. I could do 40, 70, 80 hours a week, and not come up with the pearls that you come up with. So, thanks for all your efforts, and I can't tell you how many people really appreciate all you're doing, so thank you.

**Georgi Dinkov:**

Well, thanks for inviting me. It's spreading the noise. That's what it's all about.

**Dr. Joseph Mercola:**

Yeah, you're really, really good at that. Well, we're a good team. You find it and I help spread it.

**Georgi Dinkov:**

Exactly. I unleash it and then you channel it.

**Dr. Joseph Mercola:**

Yeah, yeah, that's the way to do it. So, all right. Well, thanks for all your insights. I learned so much today, which I typically always do, which is why I love dialoguing with you about these topics because sometimes it's just reinforcing things, but most of the time, I'm learning new stuff. So, thanks again.