Harnessing the Power of Molecular Hydrogen for Optimal Wellness
A Special Interview With Tyler LeBaron, MSc., Ph.D.
By Dr. Joseph Mercola

Dr. Joseph Mercola:

Welcome, everyone. Dr. Mercola helping you take control of your health, and we're delighted to have Tyler LeBaron back with us again on his journey of continuing to learn more and more about the amazing benefits of molecular hydrogen, and that's a big difference. This is not hydrogen. And I know I was confused about simple hydrogen because that's a hydrogen ion. It's like a pH, it's an acid, but this is different. That's a hydrogen ion. We're talking about molecular hydrogen, which is two hydrogen atoms bound together, and the most common molecule and smallest molecule in the universe and it has enormous biological benefits. And it is without a doubt, my absolute unmitigated favorite for an antioxidant because it's selective. It doesn't non-discriminately suppress free radicals, which can be highly beneficial. You want hit it with a sledgehammer, you want hit it with a rifle, and it is using your body's own intrinsic biological systems and feedback to understand when you're under this profound oxidative stress.

And then it can just activate these pathways, which we're going into, Nrf2 and key proteins and causes your DNA to make the antioxidants themselves because it's not directly an antioxidant. A lot of people are confused, they think like I was, and Tyler set me straight. It's like you're thinking oh, the molecular hydrogen's going to bind with the hydroxyl free radical and neutralize it. Well, it happens, maybe, but that's just such a minute component. It's just, it helps you make your own antioxidants. Dozens of them, maybe hundreds. So, with all that preface, because you're going to do most of the talking, I'm so glad you're with us. Thank you for joining us.

Tyler LeBaron:

Well, thank you. My pleasure. I love talking about hydrogen, so it's a great opportunity.

Dr. Joseph Mercola:

Yeah. So why don't you first update us on your journeys because I know you are in the process of getting your Ph.D. in molecular hydrogen, and how's that going? Are you getting close?

Tyler LeBaron:

Yeah, no, so I had finished, I finished last year-

Dr. Joseph Mercola:

Okay.

Tyler LeBaron:

-and very excited that I was able to be in the laboratory and do a lot of the research. I've been studying this and looking at it since 2009-

Dr. Joseph Mercola:

Yeah.

Tyler LeBaron:

-and that's when I started my degree in biochemistry. And then I did a master's degree in exercise and sports conditioning and did a thesis on using molecular hydrogen. And then I transitioned into doing a Ph.D. as well. And we did molecular hydrogen research, so yeah.

Dr. Joseph Mercola:

So, did you do your thesis and you have your Ph.D. now?

Tyler LeBaron:

Yeah. Yep. It's official.

Dr. Joseph Mercola:

All right. Well, congratulations. I didn't realize that.

Tyler LeBaron:

Okay. Yeah, thank you.

Dr. Joseph Mercola:

That's fantastic. Dr. Tyler LeBaron.

Tyler LeBaron:

Yeah. Well, yeah.

Dr. Joseph Mercola:

That's great. That's really great. Well, I guess that's a big update and why don't you, well, give us an update on things and I'll just figure out where we can go.

Tyler LeBaron:

Yeah, well, I wanted it mentioned, because this has come up recently, again, you said something very important about molecular hydrogen that's not just the normal hydrogen people think about with the hydrogen ion, which is about pH and acid. But there's another misunderstanding where people are thinking that in order for something to act as an antioxidant, it has to be negatively charged and then that's going to neutralize a positive free radical or something. And that's not really what's going on. And in fact, hydrogen, as you said, yeah, it is a neutral molecule and it's not donating its electron per se to neutralize the free radicals. It could scavenge radicals like the hydroxyl radical, which then produces water. So, that's a nice stoichiometry, but really, it's regulating our body's own production of antioxidants and that's what gives it a unique antioxidant effect. And there's some different things I've seen out there talking about hydrogen that we should really be looking at H- or hydride because it has this extra electron.

Well, unfortunately that's not even possible. A hydride is extremely reactive. And to put it in perspective, in order to have a hydride, H- in water, you'd have to have a pH about 33 or so because that's based on the pKa, so to speak. I mean it's not going to work. And then anyway, we just want to, we're focusing about molecular hydrogen. All the studies that are out there, there's over 2,000 studies now on hydrogen gas, molecular hydrogen. It's all on molecular hydrogen, not on H- or H or H+, or all of these things. So, it is on H2.

Dr. Joseph Mercola:

Well, good. And as we mentioned, I mentioned earlier, the primary method, at least as I understand, certainly correct me if I'm wrong, is that it activates the Nrf2 pathway. And are there any specific antioxidants that, endogenous antioxidants your body's producing as a result of exposure to this activation of the pathway, that are more profoundly or more generously produced by your body than others? Like glutathione, that's a primary one, or what is the superoxide dismutase? Which catalyze? How many of them are there? How many of them are identified at this point?

Tyler LeBaron:

Well, actually, if you look at the Nrf2, so it's key point Nrf2 pathway. Maybe just to walk through this a little bit for the audience. In your cell you have this protein, Nrf2, and it's attached to Keap1, and they're always attached together. But when you get some oxidative stress or some other stimulator molecule, basically it can cleave off. It causes the cleaving off of the Nrf2 and the Keap2 and the Nrf2 can then diffuse into the nucleus and it binds to the ARE, or the antioxidant response element of the DNA. And then the production basically of all these endogenous antioxidants, it is the phase two, we call them the phase two enzymes of the detoxification and antioxidation. There's over 200 of these different [inaudible 00:06:09].

Dr. Joseph Mercola:

200? Wow.

Tyler LeBaron:

Yes. Yeah, it's over 200 of them. So yeah, we typically talk about glutathione as a peptide, a superoxide dismutase, catalase and glutathione peroxidase. But those are just the main ones we talk about. But there's a whole bunch of other ones, including heme oxygenase-1 that are activated or can be activated by activation of the Nrf2 pathway.

Dr. Joseph Mercola:

That's clearly, it seems to be one of its primary benefits. And its therapeutic uses are almost mind-boggling. The number of diseases or indications or conditions, actually. Not diseases, can't say that. Conditions that it seems to benefit or help or support. So maybe you can highlight some of the most important ones.

Tyler LeBaron:

Yeah, well, okay, so two things when it comes to the different conditions, you're right. Molecular hydrogen has been shown to be therapeutic in using essentially over 170, probably closer to 200

different animal disease models. And what this means is, so for example, diabetes, there's lots of ways to induce diabetes in an animal model. Maybe 10 different ways, let's say. Well, each one has a different – there's different factors, different things about it. But using these different models, we can show hydrogen has therapeutic effects. So, it is very powerful in all these ways. And like you suggest, the Nrf2 in some cases seems to be extremely important. In fact, by using gene knockout studies or microRNA like or interfering RNA, you can basically blunt the benefits of molecular hydrogen in some specific studies. So, the Nrf2 is very important to be involved. However, I think we should talk about maybe some advantages of H2 compared to other Nrf2 activators, like sulforaphane or-

Dr. Joseph Mercola:

Well, I was just going to say that, like from broccoli. I mean, and if you can compare the two because that's the tip, and most, there's many other-

Tyler LeBaron:

Right.

Dr. Joseph Mercola:

-phytonutrients that activate the Nrf2 and broccoli, sulforaphane being one of them, of course.

Tyler LeBaron:

Yeah, exactly. And people typically want to say, if you have a graph and then this Nrf2 activator is this much and this one is this much and this one is this much, and whichever one is the highest is going to be the absolute best. That's not really the right way to look at it. What we want is optimal levels, and not only optimal levels in the body, we want optimal levels in the specific cell. And so when we take something that's powerful like sulforaphane or other molecules, some of which are toxic, but many toxic molecules also activate the Nrf2 pathway. Well, in fact, that is part of the, most of these molecules that do activate the Nrf2 pathway are slightly toxic. I mean that's the whole purpose of them, right?

Dr. Joseph Mercola:

Well, tobacco smoke would be an example, wouldn't it?

Tyler LeBaron:

The which one?

Dr. Joseph Mercola:

Tobacco smoke.

Tyler LeBaron:

Oh, tobacco smoke. Yeah, exactly. Yeah, you can see upregulations of this as well. And so most things that are, like these phytochemicals or these phytonutrients, they're slightly toxic for the body, but they end up inducing these favorable effects just like when we exercise. All this extra breathing, all this oxygen, we're producing more free radicals, but then in turn, this is going to

increase our body's antioxidant status, for example, or increase mitochondrial biogenesis. So, when it comes to hydrogen, molecular hydrogen and comparing this to other Nrf2 activators, what we need to think about is some cells are already, they already have a redox homeostasis. In other words, the amount of oxidative stress or free radical production is balanced. It's a homeostasis, not truly balanced, but it has the right amount of the oxidative process and reductor process at the same time.

That's the homeostasis that we need for optimal cellular health. And if molecular hydrogen were to go to that cell, we see this in cell culture studies for example. When we administer molecular hydrogen in a cell that's already at redox homeostasis, we don't see any increase in the Nrf2 or other proteins or things like this. There's nothing like that. And so that's very important. We might see things at the mRNA levels but not at the protein levels. Now that's important because we don't want to have an issue of having a reductive stress, for example, because if you were to just induce the Nrf2 pathway indiscriminately and just keep it going, that would be called reductive stress and that would be problematic. In fact, there are genetic mutations where the Nrf2 is hyperactivated and that leads to all sorts of problems. Cancer sometimes can activate the Nrf2 really strongly and that can protect it and ensure its immortality.

And that leads to a whole bunch of problems. So, what we really are talking about is the regulation of Nrf2. So, like I said, when we take molecular hydrogen, we administer it to healthy cells, we don't see changes in the Nrf2 level at the protein level. We might see it in the mRNA level, for example. However, if we were to administer a toxin, say some pesticide or some plastic or some other stress, hydrogen peroxide or something like this, that's when we would see that molecular hydrogen was able to induce the Nrf2 or many other proteins, not just the Nrf2, and provide a protective effect. And that is so different than anything else out there. And when we look at this, and it has this pre-treatment effect as well. So, if for example, in one study, the cell culture study, they took and administered a molecular hydrogen, it was in cell culture, so it was probably only there for like an hour or so in the cell culture.

And then after that, they administered a toxin, like a common environmental toxin, like a plastic-type thing. And anyway, in this case there was the exposure caused a decrease in the antioxidant status. So, you could see markers of increased oxidative stress, you could see decrease in superoxide dismutase levels, all these important antioxidants, as well as a decrease in your NAD+ (nicotinamide adenine dinucleotide) to NADH (NAD + hydrogen) ratio, which I know you've talked about a lot before. Having a high ratio is very important. And this stress caused this reduction. However, in the cells that were pre-treated with molecular hydrogen, it prevented those reductions from happening and it provided a protective effect for 24 hours even after the hydrogen gas was out of the cell culture. So, there was no more molecular hydrogen left. And that's because molecular hydrogen works at this, basically the gene level epigenetically even, modulating the proteins and the signaling pathways and the phosphorylation cascades so we can have a protective effect for 24 hours.

Dr. Joseph Mercola:

That was an in vitro study you described, right? In the cell culture?

Tyler LeBaron:

Yeah, this study. Exactly. In the cell culture in vitro. We can see other things in animal studies as well, but this just helps hone in on that mechanism that we see. Number one, Nrf2 is very important. Number two, we're not just activating Nrf2, we're regulating its production so it's not too high, not too low. And number three, we are able to provide a protective effect for say 24 hours in this case as opposed to only when it's present. That's very amazing to think that a molecule like molecular hydrogen is able to change how the body, how the genes express themselves so that it's not going to, it's going to have favorable effects even after it's out of the body.

Dr. Joseph Mercola:

Yeah, it's pretty astounding actually, which is why I'm so fond of it. Why I think we should review the administration, some of the things you alluded to in that there's a paradox to the dosing effect and that if you take too much of it, it's actually highly counterproductive. So, I want you to review that, the optimal dosing and the different types of dosing. And I want to know if there's any updates on comparing the tablets to the gas administration, which I know is done in most of the research, maybe not most, but a significant amount of the research.

Tyler LeBaron:

Yeah, absolutely. Okay. So, when it comes to overdosing, for most people you're not going to overdose molecular hydrogen that you're able to, and that we're aware of. Because when the studies that are showing the overdosing idea, it's actually that the hydrogen was administered to the animals for 24/7. So, they were constantly-

Dr. Joseph Mercola:

Continuously.

Tyler LeBaron:

Yes, continuously exposed to molecular hydrogen and there was no spiking at all. So, in this case, the cages of the animals, of the rats, they always had molecular hydrogen, 2% hydrogen gas, always there. And interestingly, initially there was a protective benefit. You could see changes in biomarkers, you could see benefits.

Dr. Joseph Mercola:

Like the first day or so?

Tyler LeBaron:

I think it was a little bit longer actually, maybe like the first few days or a week or so.

Dr. Joseph Mercola:

Okay.

Tyler LeBaron:

But then it seemed to kind of decrease after that. But when you administer molecular hydrogen intermittently, that's when it was more effective.

And so that's the idea of having an intermittent exposure. So, it's probably not possible for somebody to take too much, you know, drink too much hydrogen water or inhale molecular hydrogen for too much. I mean, some of the studies people are inhaling hydrogen for 6 to 8, or even 12 hours a day, for example. We see therapeutic effects in this way. So, a lot of molecular hydrogen, but not this 24/7 exposure. That seems to be what the problem is. So, in terms of the optimal dose then, it's like drinking hydrogen water, one thing that we have to keep in mind then is what is the dose that is required in order to induce these favorable changes? If we go back to a cell culture, we need to add so much hydrogen molecules, so many hydrogen molecules into the cell culture, they have to interact in the cell in order for that to activate these pathways.

And that concentration, the threshold might be around 8, just say 10 micromolar, okay? So, you have to get that concentration in your cells. So, if you were to drink say 8 ounces or 250 milliliter-

Dr. Joseph Mercola:

16.

Tyler LeBaron:

Yeah, hydrogen water or something, well that's going to have a certain, depending on the concentration, that's then going to be diluted by the rest of your body. And that concentrations going to go down and hopefully it's going to be at least 10 micromolar or higher. We see some dose-dependent effects from say 10 micromolar all the way to 800 micromolar, which is considered saturation. So, there doesn't appear to be any problem with having super-high doses of hydrogen as long as they're intermittent in this way. But we want to make sure we get that minimum level. So, there are probably wrong ways to take hydrogen. And one of them then would be if you have your hydrogen water and if you just take a few sips and sit it down and then a few minutes later, a few more sips, well, you're going to take that, that hydrogen is going to be – the concentration will be reduced by all the fluids in the body. So, the concentration may never reach that, say 10 micromolar level.

Dr. Joseph Mercola:

Well, the other factor, too, is that the only reason you're able to typically get really high concentrations in the hydrogen water is that these nano-bubbles that are created by the tablet technology. And if you wait, if you keep on sipping it, those nano-bubbles are going to burst, and there's not going to be virtually any hydrogen gas, molecular hydrogen in that water.

Tyler LeBaron:

Okay. Yeah, that's another really good point. It's a little bit separate on this because even in this case we're just talking about if you have hydrogen water that's fully dissolved, that's not nano-bubbles. If you're just sipping it, then you're not going to get that concentration of hydrogen because when you drink the hydrogen, pretty much all the hydrogen molecules are going to be expelled out of the body via exhalation, most of it, within 60 minutes or so. So, if you're kind of sipping it all day, then you're not getting a high enough spike to induce those cell-signaling changes.

Dr. Joseph Mercola:

And is it homogenously diffused through the body too, or is it more of a gradient, whereas if you're swallowing it orally, there's a difference between inhaling it and its ability to penetrate all the different cellular compartments?

Tyler LeBaron:

Yes, so it does, because hydrogen is the smallest molecule, it is going to be able to permeate all the cell biomembranes and everything very easily. However, it will follow its concentration gradient. And so, it's going to, when you drink, it'll go to the stomach and then to the intestines and then onto the liver and then to the systemic circulation and through Brownian motion and this diffusion gradient, it'll be a passive diffusion, simple diffusion, go into the cells where it's going to induce those effects. So, going back to then, what's your point about in your case with tablets, because you're choosing to use that, absolutely. The concentration of the hydrogen in the tablets is not just in dissolved form, but it's in this quasi-suspended, micro-, macro nano-bubble form that has a lot of hydrogen density, so to speak, in the water. So, it's not going to be as stable. So absolutely in that case, you've got to drink it very, very quickly while it's still cloudy and everything. Otherwise, like you said, you're going to lose a high percentage of that.

Dr. Joseph Mercola:

Yeah. So, how does that compare? Because I think the percentage is 5 to 9 parts per million depending on the tablets and such? But the therapeutic dose of regular hydrogen water is like 0.5 parts per million.

Tyler LeBaron:

Yeah. Okay. So, first on a term, just on a technical term, it is much better that we use instead of PPM, parts per million, we say milligram per liter-

Dr. Joseph Mercola:

Okay.

Tyler LeBaron:

-which in this case is pretty much the same. So, 5 PPM is equivalent to 5 milligrams per liter because PPM can mean weight per weight or volume per volume or mole per mole or all these things, so-

Dr. Joseph Mercola:

Well, chemists would have to make that distinction for sure.

Tyler LeBaron:

Well, it gets confusing because often we talk about like hydrogen inhalation people then talk about 20,000 PPM, and then it's like really, because what is that, like 20,000 PPM, how does that equate to 5 PPM or something, right?

Dr. Joseph Mercola:

Right, right, right.

Tyler LeBaron:

One's percentage. The other one is a weight per weight ratio, so milligrams per liter. Yeah, you're right. So saturation, what we call saturation is if you were at sea level and you were to put a glass of water in an atmosphere of 100% hydrogen gas, then that gas would dissolve into the water and it would reach an equilibrium. The concentration it would reach would be 1.6, 1.57 more specific, milligrams per liter. That's called saturation with that. And so most of the hydrogen water that's available on the markets are going to be at best that high. But most, a lot of them, as you said about 0.5 milligram per liter, a lot of them are only hitting that level, which according to clinical studies right now, the evidence would suggest that you really need to be drinking at least that concentration in order to ensure you're going to elicit the therapeutic effect that you want in the first place.

So, unfortunately, some hydrogen products are not even reaching that threshold. But with the tablets like what you're talking about, because you are having so much that's dissolved and a lot of that are in the suspended or quasi form, then you have a very high volume of molecular hydrogen, which requires you to drink it faster, but you can get these higher doses of molecular hydrogen. So, one thing I should probably mention is when it comes to looking at hydrogen products, it's important to, one of the considerations is if it has been certified according to IHSA, and I know your tablets have gone through that process, so that we know for example, that it's really making this much molecular hydrogen. The IHSA is the International Hydrogen Standards Association, which is a group of international researchers that have come to, basically, give a definition of hydrogen water, look at all the available literature and to see what is the minimal dose, which we talked about, 0.5 milligrams per liter concentration and then also how to measure molecular hydrogen because a lot of times people will try to use ORP (oxidation reduction potential) meters or different things.

We published a paper showing how it is very inaccurate and especially if the pH is anything but neutral. So, the tablets, you might measure something like, I don't know, 0.5 milligrams per liter when really, it's 5 milligrams per liter because of the issue in the pH. So, we really can't use the ORP-type meters or other methods. It has to be gas chromatography. And IHSA uses the gold standard, gas chromatography and then does a series of testing for safety and purity and a number of different things in order to be classified as a product that could be recommended and used in clinical studies.

Dr. Joseph Mercola:

So, many indications, one of my favorites is when I travel on a plane, because you typically fly at about 35,000 feet, and for those who don't know, that's about 7 miles up, close, maybe 6 or 7 miles, and that's pretty high. That's much higher than Mount Everest. So, the protection of the atmosphere is gone and the result there's ionizing radiation from space that come through like gamma rays, so that can really do havoc on your cellular structure. So, I think it's really important to do, take molecular hydrogen. And I think the base strategy is that just like you said, you cannot take this in continuously. This is not something you want to take through 3, 4, 5 times a day. You want to take it once a day, maybe twice a day unless you're traveling. So, my approach that I've evolved to is to take it before I take off because the results, it takes a while,

maybe an hour, and you can speak to this for those ARE enzymes to be activated, or antioxidants response elements in the DNA to be activated and start producing these endogenous antioxidants.

So, you want to have it before the exposure. And then like I take it every hour when I'm in the air, just a tablet and put it in water. I learned this from you too. You want to, ideally the best amount is 16 ounces of water. That's a big chunk. You're going to get a significant benefit if you put it in 8 ounces of water, but it should not be cold because it's going to take a lot longer to dissolve that tablet. And then you got to be holding this, looking at the cup to see if the tablet is floating to the surface yet, which normally takes a minute and a half at room temperature. It could take 3, 4, 5 minutes, depending on how cold the water is, if you get ice cubes. And not to use sparkling water because the carbon dioxide in that will inhibit the, or lessen the concentration of hydrogen gas that you can have in the water.

So, that's my take on it. And I just learned recently, I don't know how I missed this, but we actually sell these tablets in little Alka Seltzer foil tablet packs. Just makes it ultra-convenient to travel with them. You just take it out of your pocket, rip it open, it's totally fresh because one of the problems with these tablets is that they're very hydroscopic, which means they attract water really easily, and when they are exposed to water before you use them, the benefit is going to be diminished. So, you want to keep them as pristine as possible until you use them. So those packets let you do that.

Tyler LeBaron:

Yeah, that's awesome. Well, just a couple of thoughts. Okay, first off, I think it's probably okay if somebody wanted to take molecular hydrogen three or four times a day. The issue would be when you're taking them, so I would say, because we just talked about the pharmacokinetics a little bit, that it takes about an hour for all the hydrogen gas to leave. Maybe it's better, this is just a maybe, we actually have no research on this is just-

Dr. Joseph Mercola:

You would know.

Tyler LeBaron:

Yeah, this is just my idea on this, okay? So, because we believe it's important to have this spiking effect, then maybe it makes sense that if you're going to have hydrogen water, you would actually not want to have it for say, you know, you want to have at least an hour break basically. That way you go back to baseline, the hydrogen level goes back to baseline so you can spike it again, okay? So that means unless you're, I don't know, you're trying to restrict water intake or something, but you could feasibly take several, quite a number of times throughout the day-

Dr. Joseph Mercola:

Okay.

Tyler LeBaron:

-as long as you're having maybe, and maybe you should try to say three-hour spaces in between or something like. Now it may-

Dr. Joseph Mercola:

Okay. At least twice a day. So that actually gets good support for the protocol I advise, which is every hour while you're flying. That would make sense.

Tyler LeBaron:

Yes, yes, you could do it that way, but maybe you could argue, "Well, but is an hour enough for it to go, for everything to be [crosstalk 00:28:21]"

Dr. Joseph Mercola:

Too low, okay.

Tyler LeBaron:

Right. So, you could wait a little longer. Now, it's not actually so important that you take it right before something because the activity, the benefits of molecular hydrogen occur not necessarily when the hydrogen molecule is in the cell at that time. That study I talked about earlier, you had all these therapeutic cytoprotective benefits long after the hydrogen was already dissipated. So, it's like as long as you've been taking hydrogen, and I would say based upon the animal studies, for about three days, then that three-day pre-treatment is going to make it so by the time you get exposed to the radiation-

Dr. Joseph Mercola:

Oh, that's brilliant, yeah.

Tyler LeBaron:

Yeah. Then you're already going to have that level of protection. Now, I don't think that if you took the hydrogen every hour or every say 30 minutes that you're going to negate the benefits. I don't think that actually would happen because you're still getting spikes, even though you're not going all the way back to baseline. So, there's probably not necessarily a wrong way to do it, but there might be some ways to optimize it or make it better. And I would just say make sure you're taking the hydrogen water, say a couple days before you're going to get on, be exposed to something and then of course before and then, yeah, you can do it after, also. But I tend to believe that a pre-treatment of molecular hydrogen is going to be more effective than a post-treatment, for example.

Dr. Joseph Mercola:

Okay, so depending on your circumstances, if you're convinced of this and you're taking molecular hydrogen a day every day, fine, it's probably closer to ideal. If you're not and you're trying to conserve and just take it for incidence of high oxidative stress, flying would be one, x-ray exposure would be another, especially CAT scan, which is like 200 times more intense than a regular chest x-ray, then you want to take it for at least three days, at least three days before the exposure so your cells are sort of saturated and primed or ready. It's like they have to, they're warmed up and ready to make what they need to. So, does that summarize what you were just saying?

Tyler LeBaron:

Yeah, yeah, pretty much. It's probably good recommendations of course that these things might, may change as we understand more the clinical evidence. In the cell culture studies, I would say that we need at least a half an hour or so. If you just look at the expression of G-protein coupled receptors, change from gene expression and then you make the mRNA and then you go to the ribosomes, make the proteins, all this stuff takes time. And so around a half an hour may be how much time is needed to start exerting some effects, right? So, 30 minutes pre-treatment before something might be important consideration. But again, you don't necessarily have to have a pre-treatment. Simultaneous treatment still can be effective. Radiation isn't something we test a lot. In fact, in my Ph.D., we used a lot of irradiation of the myocardium, for example, and I looked at the protective effects of hydrogen water.

Dr. Joseph Mercola:

What type of radiation did you use?

Tyler LeBaron:

Gamma radiation.

Dr. Joseph Mercola:

Gamma radiation, yeah, that's the type you get up at 35,000 feet. Not typically at sea level, but it is a very potent ionizing stress. There's no question. Probably one of the toughest. And I think that's the one from nuclear fallout too, if I'm not mistaken, isn't it?

Tyler LeBaron:

Yeah, I think so. Yeah, because if you're having a particle decay and alpha-

Dr. Joseph Mercola:

Yeah, yeah.

Tyler LeBaron:

-we have look at that, but there's a number of forms and they can all be toxic. In fact, non-ionizing radiation can be [crosstalk 00:32:01]-

Dr. Joseph Mercola:

Absolutely.

Tyler LeBaron:

So, it's very interesting when we look at some of the nuances and then the biological systems.

Dr. Joseph Mercola:

I wrote a whole book on that. It's called “EMF*D.”

Tyler LeBaron:

Yes.

Dr. Joseph Mercola:

And interesting, because we think, I mean it speculated, there's a lot of theories on it. I don't think any of it's proven yet. But one of the current popular theories advanced by Martin Blank, Ph.D. – not Martin Blake. Martin Pall, Ph.D, sorry. Martin Blank, Ph.D., is another EMF researcher. He recently passed. But Martin Pall, Ph.D. was at this, actually the exposure to the non-ionizing EMFs causes calcium to go extracellular, intracellular, which causes an increase or an influx of – the calcium influx causes an increase in superoxide and-

Tyler LeBaron:

The nitric oxide.

Dr. Joseph Mercola:

Nitric oxide. And you form peroxynitrite, which is actually a pretty pernicious molecule because it lasts about a thousand times longer than the hydroxyl free radical. So, I think, collectively, it may be more pernicious than hydroxyl, certainly not as acutely damaging as hydroxyl, but long term, I think. It can travel between cells. I mean, hydroxyl can only travel a very small distance, like not even the length of a protein. It's got a billionth of a second half life.

Tyler LeBaron:

Right. Yeah, the peroxynitrite is absolutely one of the most pernicious molecules. And you're right because it can be protonated too and not from nitrous but peroxynitrous acid, and then it's going to make it build a diffuse easier as well. And one of the decompositions of it is it can create hydroxyl radicals, also. So, it really is something very toxic. And so, I think that's a really good segue though, into how molecular hydrogen might help with the peroxynitrite model.

Dr. Joseph Mercola:

Yeah, yeah, yeah. Definitely want you to do it because it's my supposition, ideally, it's like this in any biology, is the best approach is prevention. So, minimize your exposure. But for whatever reason, there are so many people who just for whatever reason, are unable to limit their exposure. There's a lot of good reasons for it, but that's not the best. The best is to limit it. But if you can't, then you may want to consider taking molecular hydrogen on a long-term basis because it's going to help your body increase endogenous antioxidants to minimize the damage from peroxynitrite and other oxidative stressors. So, tell us how it works with peroxynitrite.

Tyler LeBaron:

Yeah. Okay. So, one of the first studies, actually the Nature Medicine publication back in 2007-

Dr. Joseph Mercola:

Oh yeah, the 2007, 2007, right?

Tyler LeBaron:

Yeah. Well, in addition to showing how hydrogen could act as a therapeutic antioxidant, one of the things that it found in addition to its ability to reduce the hydroxyl radicals, was also its ability to reduce peroxynitrite. So, there's one way right there, how molecular hydrogen can help is we see a reduction of the peroxynitrite levels, and we also see reductions like in animals and tissue samples of nitrotyrosine levels, which is a marker of the peroxynitrite as well. Now, you mentioned earlier that for example, if you get the calcium signals and that can induce nitric oxide and activate various NOx enzymes to increase superoxide production, and then you have superoxide and nitric oxide, and they react instantaneously. I mean, they'll-

Dr. Joseph Mercola:

Much faster than superoxide dismutation. No comparison. Or is the magnitude faster?

Tyler LeBaron:

Yeah. They are, yeah. The only thing that limits how fast they react is the rate of diffusion, basically. And superoxide dismutase is a very fast [enzyme], one of the faster enzymes. So, you can imagine this, essentially it means that if they come in contact with each other, they will form peroxynitrite. So, what we need to do then is, you mentioned this idea of prevention. Well, if we could somehow decrease this excessive production of superoxide or an excessive production of nitric oxide, then we could essentially prevent peroxynitrite formation. And that's exactly what molecular hydrogen does. And this is really fascinating because if you took other antioxidants and you put them in the presence of, say, nitric oxide or superoxide, you could also scavenge, you could reduce these, you could scavenge them. You could donate your electron and then neutralize these, basically.

Well, that can be good, but can also be bad because our body makes and specifically uses things like superoxide to increase mitochondrial biogenesis or nitric oxide, of course, for vasodilation. I think that's one of the most important molecules that there is for our immune system for every, all so many parts and functions of our organs and cells. So, we don't want to just neutralize all of these. Well, again, hydrogen being selective, if you put molecular hydrogen in the presence of superoxide or nitric oxide, there would not be a reaction. They don't have the strong enough oxidizing power for hydrogen to react with these molecules.

And so, we don't have to worry about that happening. But then the question is then how does hydrogen help with the superoxide and the nitric oxide when their levels are in excess production? And that goes to this signal modulating effects. So, as I mentioned with superoxide, typically that's from this NDPH oxidase or NOX enzymes that can become super hyperactivated. And molecular hydrogen has this ability to essentially down-regulate this NOx enzyme. And so, you end up producing less superoxide in the first place. So, if you have less superoxide, then you're going to make less peroxynitrite. And then on the other side, when you have nitric oxide production, you have three main isozymes or enzymes. You have the neuronal nitric oxide synthase, endothelial nitric oxide synthase, and the inducible nitric oxide synthase. And eNOS (endothelial NOS), of course, that's in the endothelial cells. So typically, that's good. You want more of that, you kind of lose that as you get older. Incidentally enough, side note, molecular hydrogen can actually improve eNOS.

Dr. Joseph Mercola:

Oh, that's great.

Tyler LeBaron:

So we actually can have better blood perfusion and things in this way. But there's the iNOS (inducible nitric oxide synthase) specifically from macrophages can be problematic. And hydrogen has this ability to downregulate the activity of iNOS, of making this excessive nitric oxide production. So now you're decreasing superoxide and nitric oxide levels, and consequently you get less peroxynitrite.

Dr. Joseph Mercola:

That's great. That was really, really helpful. Thank you for sharing that. And that's what we believe is one of the primary mechanisms of how non-ionizing radiation works. But then we've got ionizing radiation, and you have biological free radical production. And from my understanding, and as one of the most pernicious sources of biological free radical production is an excess of omega-6 fats, specifically linoleic acid. And so that's the substrate for it. And it's interesting, I was listening to a podcast where they reviewed the data on this, and they found that even for ionizing radiation, that the animals that had much lower tissue levels of linoleic acid had far less damage than the animals that had higher levels when exposed to equal amounts of ionizing radiation. So, even though they didn't do the study for non-iodizing radiation, it just made perfect sense that lower linoleic acid levels are going to produce less free radicals with when you're exposed to these oxidative stressors.

So, that I've become less, I mean, I've been in a course for the last three, four, maybe five years of lowering my linoleic acid levels. So, they're finally getting down to low levels. So, if you can get those seed oils out of your diet in every way, shape or form, especially in processed foods and restaurant foods, then you're not going to have a lot in your tissues. And when you're exposed to these oxidative stressors, you're not going to generate those free radicals, which ultimately cause the damage. So that's another way that you can preventively, but especially when you're using molecular hydrogen, that's like a massively effective one-two punch.

Tyler LeBaron:

Well, and this lipid peroxidation that's going to occur with the omega-6 fatty acids, all these omega-6 fatty acids, I mean, they are polyunsaturated fatty acids. They have double bonds, so they have areas where they can actually be oxidized.

Dr. Joseph Mercola:

Oxidized, yeah.

Tyler LeBaron:

And so that's just a fundamental property of them. And then that can induce this propagation cascade causing more and more. And then when you start destroying the cell membrane, that cascade's going to enter into the, down into the-

Dr. Joseph Mercola:

Mitochondria, the nucleus.

Tyler LeBaron:

Exactly, yeah. Down to the mitochondria nucleus, and then you know, then you start causing release of Cytochrome c, for example, which induces apoptosis, you know, cell suicide, and so on. So, molecular hydrogen, it's also lipid-soluble, so more lipid-soluble than it is water-soluble.

Dr. Joseph Mercola:

Really? I did not know that. I thought it was just neutral and didn't have a preference.

Tyler LeBaron:

Yeah, it has a tendency of wanting to be more lipid-soluble. So, it's several times, at least three times more soluble in lipids, for example, than it would be in water. And so, you'll actually have more molecular hydrogen in the lipid membrane. And there was a study done by [Shigeo] Ohta, Ph.D., who I've done an interview before. He's one of our MHI advisors, but his study-

Dr. Joseph Mercola:

That's Molecular Hydrogen Institute for which you founded.

Tyler LeBaron:

Yeah, yeah. MolecularHydrogenInstitute.org. Yeah, but anyway, in his study, and it's very interesting, but this was an in vitro cell-free study basically taking basically a cell membrane-type idea and administering a small percent of molecular hydrogen so it could equate to what it is physiologically. And when you don't have the hydrogen present, then you get this autooxidation. Okay, that's just oxygen comes, it causes oxidation. You get this propagation. What ends up happening is you form these byproducts, lipid peroxide byproducts, like 4-hydroxynonenal. And then this sequesters various other complexes, which prevents activation of AKT, different protein kinases, and then eventually that can cause problems, okay? Because you're suppressing these activities. Now, when you administered molecular hydrogen, there was less production of these lipid peroxide end products. And consequently, there's less of the inhibition of these molecules. So, these molecules, these protein kinases for example, they in turn end up activating things like PGC-1 alpha, which is stimulus for mitochondrial biogenesis, then eventually fibroblast growth factor 21, which is a hepatic hormone, which is important for energy expenditure and weight loss. And so, like caloric restriction and some of these benefits come in with molecular hydrogen. And it all came from molecular hydrogen protecting the cell membrane, basically, from this autooxidation.

Dr. Joseph Mercola:

That's tremendous. I didn't realize it was so beneficial for that, but it makes perfect sense. It just never occurred to me. That would be another useful strategy. So, as long as we're expanding on this, but those were two really, profoundly important fundamental biological challenges because with oxidation, because why is it so important? Because so many experts now believe that one of the ways that aging is accelerated is through oxidative stress. So, we really need to have a good handle on this, and you got to be careful and you just can't be, well, you could, but we don't recommend indiscriminately swallowing these antioxidants. It's so far superior to allow your body to do it in its own wisdom and based on the feedback it has from the environment with oxidative stressors.

Tyler LeBaron:

Well, there's data also that taking these high doses of synthetic antioxidants, they actually increase mortality. I mean, you end up dying faster. These are the early studies. Like they found that smokers, for example, who ate more carrots or something, they're like, hey, they're living longer. So, they were recommending, "Hey smokers, you should make sure you get a lot of vitamin A and beta-carotene." Then they're like, "Hey, we should do a study on this to actually make sure that these recommendations are sound." And they were taking different studies and sometimes high doses, you can call them synthetic. It doesn't really matter. The point is these are reducing agents, reducing molecules that have the ability to neutralize free radicals. And they had to stop the studies because people who were taking the antioxidants were dying and getting cancer faster than those on the placebo. And in fact, the recommendation is like, "Be careful about taking these, especially if you smoke."

Dr. Joseph Mercola:

Yeah, there you go. So, it exactly perfectly illustrates what I just said. That's great. So yeah, it occurred to me too, there's another area that I became recently aware of, of reductive stress, which is an interesting concept because most people don't know about it, but it's when you have an excess of these omega-6 fats and specifically linoleic acid that it perturbs the electron transport chain. So, you get backward flow and it actually increases reductive stress, which is a challenge.

Tyler LeBaron:

Yeah, that's interesting. Yeah, so there's probably two different ways of looking at a reductive stress in this case. So yeah, when you're looking at the mitochondria, so the university that I teach, of course, bioenergetics, is an exercise nutrition for my master's class students that I'm teaching. And we kind of go through some of these pathways in detail. But yeah, if your mitochondria are not functioning correctly, then if you get backup with electron transport chain, then what happens is yes, those electrons, instead of going to oxygen as a final electron acceptor to form water, you end up donating it to oxygen prematurely or other molecules, and that causes more free radicals and can be problematic in this case. And then the poor-functioning mitochondria, if you're not able to regenerate your NAD+ levels because that's so important for our overall health, then you end up having more and more of NADH, and this leads to more and more of your NADPH, because you have NADP and NADPH, and NAD+.

Anyway, you can start having this type of reductive stress. It can be problematic from a metabolic perspective. But then there's this other idea of a reductive stress in terms of having too many, like I mentioned earlier, this upregulation of the Nrf2 pathway, for example, like happens with cancer or some genetic issues. We're just taking high levels of antioxidants. That's a reductive stress. And so, you're absolutely right, with aging and diseases, it's not so much an oxidative stress. We focus on that, but it's really a dysregulation, it's a redox dysregulation. And in fact, we've seen in some of these aging cells, you can have a dysregulation of redox within the exact same cells. So, for example, in the one compartment we'll say that the ribosomes, which is responsible for folding proteins, and so you need to have some oxidative power in order to fold proteins correctly.

But as cells get older, they may lose that ability. And if you don't fold your proteins correctly,

then they're not going to function correctly because the function of a protein, the structure of the protein dictates its function. So, this is one problem. And then in the same cell in the cytosol, let's say, you can have too much of an oxidative stress going on. So, you have reductive stress going on in the ER, endoplasmic reticulum, and an oxidative stress going on in the cytosol. And different compartments can be, all have different issues going on. And so again, just taking an antioxidant or taking just sulforaphane or just taking whatever, that might help one compartment, but it might exacerbate the other. So, what we really want is a regulator, a redox regulator, and that's kind of like what molecular hydrogen seems to do.

Dr. Joseph Mercola:

It is what it is. That's a perfect description of it.

Tyler LeBaron:

Yeah. Adaptogenic redox regulator, basically.

Dr. Joseph Mercola:

Is that a term you came up with, adaptogenic redox regulator?

Tyler LeBaron:

I did actually. I published a paper, yeah, I called it a "mitocore-medic redox adaptogenic regulator."

Dr. Joseph Mercola:

I love it. That's great. That's great. You coined a new term in scientific jargon. Congratulations. So, one of the other things I admire about you is commitment and passion about exercise, that passion we both share. You're significantly better at implementing it than I've been. You won the state championship in Utah for wrestling when you were in high school, I believe. And ran a sub 2:30 marathon and you dead lifted over 500 pounds. So you're an extraordinary physical specimen. So, I'm wondering if you could maybe touch on the use of molecular hydrogen for exercise, exercise performance and some of the benefits there.

Tyler LeBaron:

Yeah, so again, we actually published a paper on this in the Canadian Journal of Physiology or Pharmacology a few years ago. But the studies are, there are quite a number of them showing that we can have improvements in say, our endurance levels or, well, I kind of want to go through some of these a little bit. I was just reminded there was just an article published as well, a systematic review, meta-analysis on the benefits of hydrogen for exercise. And it was just recently published this year actually. And again, meta-analysis are some of the strongest evidence that science has to offer, and it shows its favorable effect.

Dr. Joseph Mercola:

If the articles it's evaluating are valid, because they used that to totally screw with us in the COVID narrative. And they picked the wrong studies to do meta-analysis with.

Tyler LeBaron:

Yeah, that's one of the problems with meta-analysis in general is typically it's only valid if we know the authors have a level of expertise in this area. But, okay, so some of the benefits with hydrogen for with exercise, for example, so first it seems to be if it's going to help you, it's probably going to help you as you push yourself harder. So the further away you are from homeostasis, the more you're likely to see an effect in terms of helping the perceived exertion or helping with your blood flow, for example, or helping to reduce fatigue. And so, some of the studies, like one of earliest ones, found ability to prevent fatigue during a maximal isokinetic knee extension exercise. So, in this study, basically isokinetic just means same speed, and so you're on a machine and you're just doing these leg extensions. You have to do, I think they did 50 of them in a row, and you just do as hard as you can.

And then the group that took molecular hydrogen was able to maintain a higher force output during those 50 maximal isokinetic knee extensions. And then also they looked at exercising at around 70% your VO2 max, which is about close 70% of your max heart rate. And those who were doing this, they were able to exercise longer, like a longer time to exhaustion, for example, but also had lower levels of lactate. So, lactate, there's a lot of misunderstanding about lactate. We've heard lactic acid causes the burn or something. None of that is true. Yeah, lactic acid is, actually lactic acid itself is not even produced in the body. The only lactate, the molecule lactate is, in fact, I have one of my exercise phys textbooks, it still has lactic acid in there, and it says that lactic acid is made and then it disassociates into lactate and the hydrogen ion, which again, it's not true. In fact-

Dr. Joseph Mercola:

Tell us, I thought it was at the pyruvate metabolism.

Tyler LeBaron:

Yeah. So what happens is yeah, pyruvate is the end of the-

Dr. Joseph Mercola:

Glycolysis.

Tyler LeBaron:

Glucose and you make pyruvate. What happens is lactate dehydrogenase, the enzyme, then takes pyruvate and adds two electrons and a hydrogen ion, which is the acid, adds a hydrogen ion to the pyruvate, and that forms lactate. So, the molecule lactic acid is never produced. Okay, but I don't want to go too far in the weeds. I'll go really off on a topic, but I want to talk about this lactate just real quick. The reason why we produce lactate is because pyruvate, normally, will go to the mitochondria, to this PDH (pyruvate dehydrogenase complex) complex and it's oxidized into a acetyl-CoA. It goes, anyway, then you go end up making a bunch of ATP or energy in the mitochondria with using oxygen.

Dr. Joseph Mercola:

Right, aerobic respiration.

Tyler LeBaron:

Exactly right. Okay. So, if your mitochondria are unable to keep up with the demand, with the ATP demand of the amount of exercise, so it's not able to make enough ATP using the mitochondria, using this pathway because maybe you don't have enough mitochondria, maybe you're not getting enough oxygen there, it's just taking too long. And so-

Dr. Joseph Mercola:

Yes, or the exercise is too hard.

Tyler LeBaron:

Well, or you're exercising too hard, but that's because your body's got to get better, right?

Dr. Joseph Mercola:

Yeah, yeah.

Tyler LeBaron:

So, what happens then is you start producing lactate. So, lactate is this byproduct. So, because the production of lactate is what allows you to continue exercising, it's what allows you to continue going at that high intensity and you can make lactate instead of having a build-up of pyruvate. It's actually a build-up of NADH, which is the issue. Okay. Now in the study then, when they found that you have a reduction of lactate, what that means is that, well, okay, one interpretation is that the molecular hydrogen may have improved the function of the mitochondria. And we see this in other studies where we actually see increased energy production, so increased ATP production in the mitochondria. Now, if we're getting our ATP production from the mitochondria using the aerobic respiration, then we don't have to go through the anaerobic pathway of making lactate. So, that's kind of the important area of why we're seeing lactate decrease is because we're able to use the mitochondria to make ATP and now we can exercise better, longer and have less fatigue, especially the perceived exertion in our brains as well. And then there's also maybe other explanations in terms of lactate clearance and accelerating the Cori cycle and different things. But the mitochondrial bioenergetics are probably a major target of molecular hydrogen.

Dr. Joseph Mercola:

Excellent. Well, thank you for expanding on that. So, mucho benefits when you are exercising. It's a really good idea if you want to optimize and maximize your investment in time and effort and energy. If you're going to put in the work, you may as well optimize it with some molecular hydrogen.

Tyler LeBaron:

And as protective, because as we said, when you exercise, you do breathe a lot more and that's going to make more free radicals. And a lot of those free radicals are going to be very good for your body because it's going to force you to make more antioxidants, it's going to increase mitochondrial bioenergetics and all this stuff, but you're still causing damage. You're still damaging DNA, you're still doing things. So molecular hydrogen, the idea here is that you can

negate or reduce the damaging effects of exercise while not inhibiting the benefits of exercise, and in fact, maybe even potentiating the benefits of exercises.

So, this is one of the ideas that hydrogen in some ways can act as an exercise mimetic not in the true sense, maybe a pseudo-mimetic because it can activate some of the same pathways, some of the same metabolic pathways that exercise does. And in this case, it can maybe really potentiate those benefits of exercise. Then again, to compare that to conventional antioxidants, especially in animal studies we see this, that taking high dose of antioxidants can negate the benefits of exercise training. So normally with exercise, you have improved insulin sensitivity, your glucose levels go down, you know, have better antioxidant status. Taking high levels of synthetic antioxidants can completely negate those benefits of exercise. So again, hydrogen is superior because it doesn't do that.

Dr. Joseph Mercola:

Does it obliterate the external antioxidants as you would swallow? Is it somewhat similar mechanisms as cold-water immersion or cold thermogenesis?

Tyler LeBaron:

Well, I guess the end result would be the same, but conventional antioxidants and-

Dr. Joseph Mercola:

Different mechanism.

Tyler LeBaron:

-cold immersion, yeah, different mechanism. But there of course is going to be some interplay because free radicals are always at play. But there's also things like the chaperone proteins, the heat-shock proteins-

Dr. Joseph Mercola:

Sure.

Tyler LeBaron:

-and different things that are in clearing of like calcium, inorganic phosphate and things in the muscle.

Dr. Joseph Mercola:

I love heat shock proteins. Most of my heavy workouts are followed by near infrared sauna. I get up to like 180 [degrees Fahrenheit] or so, and my body temperature is like 102 for only 20 minutes. And that's one of the, I love activating heat-shock proteins because as you mentioned earlier, those protein unfolding is a huge problem. If your proteins, you can have a protein, but if it's misfolded, it's not going to work.

Tyler LeBaron:

Yeah. Well, and molecular hydrogen also induces the heat-shock protein response.

Dr. Joseph Mercola:

Oh, I didn't know that.

Tyler LeBaron:

Yeah, so some of some of my colleagues in Japan, they did several studies. We actually published one recently, but we've see the – yes, molecular hydrogen is able to indeed deduce mtUPR, the mitochondrial unfold approaching response, and then this is important because then this could result later in rejuvenation of the mitochondria, for example. So, there's lots of heat shock proteins, but hydrogen is involved in this, and then it induces later in upregulation of collagen biosynthesis as well as some of these same pathways.

Dr. Joseph Mercola:

That's terrific. That's great. So, I was thinking as we were elucidating the mechanism with the omega-6 fat, linoleic acid, which I view as probably one of the most pernicious contributors to chronic degenerative diseases. So, heart disease, cancer, diabetes, obesity. And it's not because it's a direct toxin by itself, but as you mentioned earlier, it's the byproducts, the ALEs, that's referred to advanced lipoxidation end products, which is similar to AGEs from carbohydrates, advanced glycation end products. But these ALEs or even oxidants, more specifically oxidative linoleic acid metabolites, the metabolites, and there's hundreds of them, 4-HNE is just one, but there's hundreds of them that contribute to – they're independent free radicals that damage the cell tissue. So, if you can lower those, that production of those three radicals to begin with, you're probably radically contributing to almost every chronic degenerative disease.

Tyler LeBaron:

Yeah, that's why we can explain that molecular hydrogen can have such a wide, diverse benefit in so many different disease models because essentially all of them have this root cause of an excessive amount of oxidative stress or redox dysregulation we talked about, or this inflammation. And hydrogen [being] able to regulate these pathways is going to help with the root cause as opposed to a certain drug that's going to target a very specific receptor, go into this specific organ that's going to one target, one organ and one effects-type idea and that's just not how molecular hydrogen works. It's able to work on the oxidative pathways, on the mitochondria, on autophagy. I mean there's so many areas where molecular hydrogen works and so it makes sense that it should be able to help with so many different conditions.

Dr. Joseph Mercola:

Yes, indeed. Well, I love it. As I said earlier, it's my favorite antioxidant because it's selective. It's not like any other antioxidant and really, is really one of my absolute favorite supplements and I embrace widely. So, what's on the horizon for you? You got any exciting research that you're working on or any theories that you're seeking to approve?

Tyler LeBaron:

Yeah, well, there's a number of things. So, maybe we'd really like to understand, still, the mechanism of hydrogen in terms of what is it actually exactly binding to, what's a primary target and then this is going to induce this and so on. So that's still being uncovered right now. There is a brand new article that came out that could be a kind of groundbreaking article. We need some

more research to validate it, but a hydrogen, that's kind of a complicated thing, but I'll make it very simple though. But this paper just came out and we have the hemoglobin that can get degraded and form different – it forms different things during its degradation process. And hydrogen can interact with some of these and actually form this association with some of the iron complexes in this case. And this ends up acting maybe as a catalyst for which hydrogen can neutralize free radicals and prevent oxidative stress.

And it can be attached to these proteins in the body that circulates all throughout the body. So, it can be brought through the brain, through all the organs and everywhere else and could help mediate a lot of the effects that we're seeing with molecular hydrogen. So that's a very interesting study. More data needs to be done, but it's pretty neat that we are actually seeing how hydrogen is able to maybe bind to some of these novel proteins in the body.

Dr. Joseph Mercola:

Yeah.

Tyler LeBaron:

So that's one area. And then another interesting thing is some people seem to be much more sensitive to the benefits of hydrogen than another. And this is just kind of anecdotally, but even when we look at sub-analysis, some of the clinical studies, like we published a study on using – we actually used hydrogen producing tablets and it was six months in metabolic syndrome and we found improvements in cholesterol and glucose and liver enzymes and weight loss and things.

But looking at the data, it almost seems that some people are going to respond better than other people do, for example. And so, trying to hone in on what this sensitivity might be, and it's possible that, maybe, has something to do with our gut microbiome because we naturally produce hydrogen gas and our intestines produce hydrogen gas naturally, but people produce different levels. Some produce a lot, some people don't produce any at all, in fact. And then it's going to depend on our diet, what type of diets we're going to have. And so there might be something going on here that would make one person more sensitive to another and hopefully we can hone in on that. And then we were talking earlier about, I did update our website, MolecularHydrogenInstitute.org. So, you know right now we're able to offer some excellent education about molecular hydrogen, what it is and what it isn't. There's so much confusion out there.

Dr. Joseph Mercola:

You've got some courses too, that you put together.

Tyler LeBaron:

Yes, exactly. Yeah. So, I'm hoping that if you're interested, if anyone is interested in learning about molecular hydrogen and just trying to understand the principles and things behind it so you can answer your own questions, these courses are really going to help because there's a lot of information out there that's not correct. And so, these courses are specifically designed to eradicate a lot of the misinformation, get the correct information and allow you to think about

how to use molecular hydrogen the best, how to optimize and so on. So, I think people are going to really like them.

Dr. Joseph Mercola:

Perfect. So, definitely head over there. MolecularHydrogenInstitute.org. Two closing questions. One is the difference, the contraindications. Are there any for molecular hydrogen? I do recall in the past that there was a concern with SIBO or small intestinal bowel overgrowth. Is that an issue or are there any other contraindications that someone should be concerned about using molecular hydrogen?

Tyler LeBaron:

Yeah, so we don't know. That's just a possibility, right? Because yeah, if you have, and there's different types of SIBO where you have the methanogenesis and more are just hydrogen-producing. And so, if they're using a lot of molecular hydrogen as an energy source, the bacteria to produce more methane for example, than maybe if you're feeding more of that hydrogen, then it could be problematic. That could be true for some people, but for other people it probably wouldn't be true because they also have a lot of hydrogen-producing bacteria. So, there's already a lot of substrate in the intestines themselves. And so, adding a little bit more molecular hydrogen may not change anything at all. In fact, maybe there's even a negative feedback process that's going on that can make it better. So, if that's a concern, I mean you could try it and if you feel worse or something then you know maybe it's not for you right now, so there's that aspect.

And then in terms of contraindications, again, currently with what we have seen in the literature, there does not appear to be any contraindications. The bigger contraindications would be if you are using, your method of making or using molecular hydrogen is not a very good way, for example. So sometimes I've seen people take just pieces of metal and put it in water and then they'll do electrolysis because they'll produce a little bit of hydrogen gas in there. Yeah, you do make some hydrogen water, but the concentration's low and then all that electrode material can be degraded and then leached into the water basically. And then you're drinking that. So, that, of course, could make you not feel very good or make you sick or cause problems. Or if you're overdosing on, I don't know, drinking too much water, drinking several gallons of water a day of hydrogen water or something, trying to get a bunch, that's just too much water, it's going to mess up your electrolyte balance.

But in terms of just molecular hydrogen, still there doesn't appear to be any contraindications. So, it seems to be something very safe. And honestly that's why I feel comfortable talking about it, even recommending it. At least I certainly don't discourage people from using molecular hydrogen, it's just that the safety profile of molecular hydrogen is very high. We see this from many cell culture and animal studies and human clinical studies and it's naturally produced in our intestines and everything else. So, because the safety profile is so high and the potential benefits appear to be, well, quite remarkable, then the risk-to-benefit ratio is really quite favorable. And so, I think we can go ahead and try to enjoy the benefits of molecular hydrogen without [crosstalk 01:08:40].

Dr. Joseph Mercola:

Well forget the try. You can just enjoy it. Yeah, you can do it. It's really great. So finally, with respect to alternative methods in administration, what about, can you review hydrogen gas because there's some devices out there that make hydrogen gas. I've been in the process of seeking to get one made overseas and I'm seeking to get one made for you too, but like a 7% concentration. Totally different mechanisms. Can you just maybe provide some insights as to the comparisons of the two? Now, the gas machines are much – and you could actually use hydrogen gas itself from a same company that would sell you oxygen gas. You can breathe that in, but that would be, I think, a hundred percent, maybe you can combine it with oxygen.

Tyler LeBaron:

Yeah, we do that in the laboratory and in fact, this is a concern. In most clinical studies, that's exactly, okay, maybe not most anymore, but in many of the clinical studies, especially the ones that are done in the hospital settings, that's what is done. It's a tank of very pure hydrogen gas that is mixed with medical grade oxygen gas. And so, it's just very high purity. And so, the percentages are exact. And so, when you inhale that you're inhaling that specific percentage of 2%, 4% or whatever it is. Now when it comes to these machines that produce the molecular hydrogen, that's all great, assuming that the machine is not putting contaminants into the gas or something like this, normally shouldn't be a problem. But the issue is the volume of hydrogen gas even going to be enough because, just because something is 2% or 1% or 7% or something, well, 7% of 10 is 7. 7% of 10 milliliters per minute is 7 milliliters per minute, and 7 milliliters per minute is not going to be therapeutic for you.

So, you have to make sure the volume is much higher, closer to 200 to 300 milliliters per minute, kind of at a minimum based upon the studies. So, there's a number of things to look at in this, but then in terms of the benefits, say, compared to hydrogen water, more research needs to be done on that. And in some cases, it appears that the drinking hydrogen water can be more effective. And in fact, in certain cases it's like a hundred times more effective just looking at different protein expressions, for example. But in other scenarios, the inhalation might be able to work on different pathways, different areas that the drinking cannot, and so they don't really compete with each other and there could be an additive or synergistic benefit from them. In the past, I would say most of the research has done on drinking hydrogen water in clinical studies, and that's still probably the case, but there are more and more clinical studies being done now with the inhalation of molecular hydrogen that are showing favorable effects.

Dr. Joseph Mercola:

Okay, that's great. All right, well thank you for that. I think we're going, because I had these technical difficulties with my video camera and had to switch backup. I think we're going to probably end it there. But I really appreciate everything you're doing and all the information you shared with us. And thanks for everything that you've put together so far.

Tyler LeBaron:

Yeah, my pleasure. And always great to talk about hydrogen, and thank you for your time and I appreciate it.