Enhancing Autophagy and Upregulating the Mitochondria With Molecular Hydrogen: A Special Interview With Tyler LeBaron

By Dr. Joseph Mercola

Dr. Mercola:

Welcome, everyone. This is Dr. Mercola, helping you take control of your health. Today, we have a real treat for you. We are joined by Tyler LeBaron, who is the founder of the Molecular Hydrogen Institute, and really one of the most knowledgeable people in the United States about molecular hydrogen, which is by far, I believe it's my favorite supplement. If I was going to have a favorite, it would be molecular hydrogen because of its incredible benefits.

Dr. Mercola:

We're going to talk about what some of those are, and Tyler was really the one who helped me understand this and continually contributes to my evolution of thinking on the proper application of this. So, welcome and thank you for joining us, Tyler.

Tyler LeBaron:

My pleasure. Thank you. Yeah. It's always great to have the opportunity to talk about some of the research that I have been fortunate to be involved in.

Dr. Mercola:

Yes. When we last talked, I don't think you're formally involved in your Ph.D. program, but now you are, and because of all of the studies that you published previously, you're on an accelerated path, and you're going to be having your Ph.D. soon. So, why don't you just briefly describe that and then we can go into some of the new science?

Tyler LeBaron:

Yeah. I've been lucky to be involved in the hydrogen research for quite some time. Of course, I've put off a little bit. I've started my Ph.D. earlier because I wanted to do it in molecular hydrogen, then I had the opportunity several years ago. So, I've been able to really work with a lot of different groups and especially some of the stuff we're doing right now, and things are going really well, and we're finding some really exciting things that I'm excited to talk about.

Dr. Mercola:

Yeah, yeah. So, you're doing a lot of traveling because you're doing your Ph.D. work in Europe, and you're still taking your regular pass back to China, I believe, or is it Japan?

Tyler LeBaron:

Well, China and Japan. Yeah. So, I collaborate with both people, some different people groups in Japan, as well as in China. China, more so recently, well, I was going to say more recently, but now with the coronavirus-

Dr. Mercola:

Coronavirus, yes.

Tyler LeBaron:

Yeah. Well, I was there in December, and then I was there at the beginning of the month in January right before a lot of the outbreaks really started taking off.

Dr. Mercola:

Well, the outbreak started in December. That was the beginning in Wuhan.

Tyler LeBaron:

Well, I mean, before they grew so much that the airports were being closed down and everything because I was right there in Shanghai, and then a couple of weeks after I got back, that whole city became under a lockdown, basically.

Dr. Mercola:

Yeah. So, well, I'm glad you made it back.

Tyler LeBaron:

Yeah, yeah, me, too.

Dr. Mercola:

We're quarantined out there. So, before we begin in some of the exciting research, I think it might be wise to summarize a bit at least of some of the benefits of molecular hydrogen and why it works maybe in a few minutes, and how it's a potent selective antioxidant, and unlike typical traditional, conventional antioxidants like vitamin C and vitamin E, when taken in excess can be actually highly counterproductive, and really nullify some of the benefits of hormetic stressors that we're put through like exercise.

Dr. Mercola:

Whereas hydrogen doesn't have that downside, which is one of the reasons why it's my favorite. I think there's almost no downside to molecular hydrogen. So, why don't you just summarize the reasons why someone should be interested in this?

Tyler LeBaron:

Yeah. Absolutely. Just to make sure everyone's on the same page when we're talking about molecular hydrogen, we are talking about the gas, the H2 molecule, just one hydrogen and another hydrogen that they bind together and they form the H2 molecule.

Tyler LeBaron:

Typically, when we hear about molecular hydrogen or hydrogen gas, we think of maybe an alternative energy source because it's three times more energy dense than gasoline. It turns out that although it can be used as an alternative energy source, it can also be used as an alternative medicine, so to speak. This molecule, also because it is so small and it's the smallest molecule in the universe, smaller than oxygen even, it's able to diffuse through the cell membranes like the blood-brain barrier, for example,

the subcellular compartments, into the mitochondria, the nucleus. It's able to get everywhere very easily, very quickly because it is so small. It doesn't need specific transporters.

Tyler LeBaron:

That's a critical part to just consider for a little bit in order for a molecule or a nutrient or vitamin to do any good for you in the place, you have to actually get it inside of the cell. So, this bioavailability becomes one of the major factors in all pharmacology and nutraceuticals, and so on.

Tyler LeBaron:

Some of the things that dictate cellular bioavailability is, number one, its size, and the smaller the molecule, the easier it can get inside of the cell, and hydrogen gas, as we mentioned, is the smallest molecule. So, it beats every other molecule out there.

Tyler LeBaron:

Then another part is its charge and polarity. Well, hydrogen gas has no charge. That's very critical because if it was charged, say like an ion, so just think of, say, potassium ion or a sodium ion, these are very small ions, but because they're charged like this, they cannot go through the cell membrane. They have to go through a protein channel in order to get through the cell membrane.

Tyler LeBaron:

The other thing is — Even like water. So, water is a neutral molecule. It looks like Mickey Mouse, oxygen and the two hydrogens combined, right? Of course, that's very different than molecular hydrogen because notice in this case with the water, the hydrogens are tied to the water molecule. So, it's totally different. With that water molecule, although it is neutral, it has a polarity. The oxygen has a slightly negative charge, and the hydrogens on the water molecule are slightly positive. That also prevents it from going through the cell membranes, and it has to go through a protein channel called aquaporins.

Tyler LeBaron:

So, again, because hydrogen gas is small, it's neutral, and it's nonpolar, it allows it to enter through the cell membranes and diffuses the subcellular compartments easier than anything else. So, it has, truly, the best or most favorable distribution properties of pretty much any other supplemental molecule that you could have dreamed of, in fact, that you could even create if hydrogen gas is already there.

Tyler LeBaron:

So, that's a very important part about the pharmacokinetics and how hydrogen gas can get into the cells. Now, going to some of the benefits, I guess we can talk about just some of the brief things. We are finding out that hydrogen gas is able to suppress or decrease excessive oxidative stress, as well as excessive inflammation, as well excessive perturbations from normal homeostasis. Maybe we should dive in to each one of those areas a little bit to explain why it's important about this excessive that I'm talking about.

Dr. Mercola:

Yeah. The key point is emphasis on the excessive because it only addresses excess oxidative stress because some oxidative stress and some free radicals are beneficial. Nitric oxide would be a classic example.

Tyler LeBaron:

Yeah, yeah. Thank you. Exactly. Maybe many people don't grasp that initially. We just think of oxidation is really bad, which it is, right? Again, we know that when you cut your apple in half, your avocado-

Dr. Mercola:

An excess.

Tyler LeBaron:

Right. Yes. When you have your fruit or different things, you have the oxidation. That's what causes the brown. It's what causes rusting. The exact same thing really does happen in our body as we breathe the oxygen. When we exercise more, we're breathing more oxygen, and that is causing this oxidation. So, that process is always occurring. In fact, that's how we metabolize food, is through the process of oxidation, but that oxidation that is necessary for a life to exist is also the very thing that is solely taking away your life, if you will.

Tyler LeBaron:

So, oxygen does have this toxic effect as well. Like you mentioned, I'm glad you brought up nitric oxide, that is by definition, a free radical. It has a lone pair of electrons, but, of course, nitric oxide is one of the most important molecules, some of the molecules that there are, it induces vasodilation and a whole host of wonderful and very critical benefits.

Tyler LeBaron:

We're seeing other things, including superoxide radical. That also is a free radical, but it's extremely important. So, very important that we understand that it's about the excessive oxidative processes going on. That's when we get into ... Well, because we have our body's natural antioxidant systems already, and we have to have that in order to fight against this toxicity of oxygen.

Tyler LeBaron:

So, when you look at plants, for example, one of the reasons why we want to eat plants, we get antioxidants from plants because plants also developed ways to handle this toxicity of oxygen. So, plants develop antioxidants. When we eat the plants, we get some of those antioxidants, right? So, that's how this process works.

Tyler LeBaron:

Now, that oxidative process or that oxidation that's occurring, some of the things are involved besides cell signaling, but also even for protein folding. So, when you fold your proteins, you sometimes have to have an oxidative power in order to get the correct folding of the proteins. This happens in, say, the endoplasmic reticulum of the cells.

Tyler LeBaron:

If your proteins are not folded correctly, they're not going to have the right structure, and that's the fundamental principle of biology and biochemistry, that structure dictates function. So, if you don't have the correct structure, then they're not going to function correctly. It turns out that aging is often associated with a decrease in this oxidative power or oxidative potential that is required to fold your proteins correctly.

Tyler LeBaron:

So, you actually have a lack of oxidative power going on in the endoplasmic reticulum, while at the same time, you're suffering from an excessive amount of oxidative stress that's going on in the body. So, that's very interesting to consider that in the exact same cell, you're having an oxidative stress, maybe in the cytoplasm, as well as a lack of oxidizing power or potential in the endoplasmic reticulum.

Tyler LeBaron:

We can call this a redox dysregulation. When you have this homeostasis of redox – redox meaning oxidation and reduction – when you have this dysregulation, that's really what sets the stage for diseases and aging, and a whole bunch of other pathological problems.

Dr. Mercola:

Yeah. There are tools like hydrogen that can help resolve that, and there are other tools like saunas, especially for the misfolded proteins, which could be particularly beneficial because they create these heat-shock proteins, which are particularly beneficial for refolding or removing the damaged proteins.

Tyler LeBaron:

Yeah, yeah. Exactly. It's interesting even with sauna and different things and exercise, when we do some of these different therapies, whether it be photobiomodulation, exercise, the sauna, a lot of this actually mildly increases oxidation in the body. That oxidation in the body is what induces heat-shock proteins.

Tyler LeBaron:

So, the production of heat-shock proteins is because there was some damage, a mild damage that resemble the body, and then we get these heat-shock proteins, and we call this hormesis. This is an important word because we're going to about this a lot when we talk about the benefits of molecular hydrogen because it seems to work through some similar processes of hormesis.

Tyler LeBaron:

So, when it comes to the oxidative stress that's going on, we really need to get that back into homeostasis. We can't just come in and neutralize all the free radicals. So, many antioxidants, they contain this, it's called the conjugated pie system, where it just have a whole bunch of electrons that are able to easily donate, and scavenge, and react with a whole bunch of radicals or oxidants indiscriminately, and neutralize them.

Dr. Mercola:

Let's give an example of this. With intravenous glutathione, which is frequently administered in many alternative medicine clinics, would that be an example?

Tyler LeBaron:

Yes. Absolutely. Yeah, intravenous glutathione. In fact, almost every standard antioxidant that we're aware of can fit into this criteria. In almost every single case, well, and I say that because there are probably some cases where it's not true, but I can't think of any, when you administer a whole bunch of them for a long time, you end up increasing a dysregulation of the redox homeostasis because you're causing a too high of a reductive environment, and the cell can't keep up with this, and you start getting problems.

Tyler LeBaron:

Even genetically, when you do genetic mutations to, say, have a constituently upregulated Nrf2 pathway, which we'll talk about later, but Nrf2 causes more antioxidants. When you have this, then you end up having a lot of other problems – cardiomyopathies, and this overtly reductive environment in the cells can lead to a lot of problems.

Tyler LeBaron:

So, absolutely, that's why taking lots of antioxidants all the time day in and day out for years, it simply causes a lot of problems. In fact, they've had to stop a whole bunch of clinical trials because those taking these antioxidants were dying faster than those taking the placebo.

Dr. Mercola:

Yeah. There was a common theory of aging, Darmond, I think Darmond Harden is the guy who started it in the '50s, and it's become less popular now, but that suppressing this oxidative stress with antioxidants was one way to slow down the aging process. As you just mentioned, the studies don't bear that out.

Tyler LeBaron:

Yeah. Exactly. Now, of course, there are studies in different animals. There are studies in different fruit flies, and there are different things showing that, clearly, oxidative stress absolutely contributes to aging, but that's with oxidative stress, and that's really what's occurring.

Tyler LeBaron:

Sometimes antioxidants can even exacerbate oxidative stress because they can increase Fenton reaction cycles and redox cycling, and end up being potent pro-oxidants and things as well. So, it is very complicated, and we have to be very cautious.

Tyler LeBaron:

We can even talk about some of those studies with the vitamin E or beta-carotene, "Oh, those are just synthetic," and that's why they're having these problems; they weren't taking the right form. Whatever way that we want to describe that, the fact is these are still antioxidants in the conventional sense. They're still reductive molecules. They still had a negative impact on the body, and it's possibly because of this excessive amount of reductive character that was going on.

Tyler LeBaron:

Hydrogen gas simply doesn't do that. In fact, one of the reasons we know hydrogen gas could be so safe is because it simply does not have the reductive power or potential to neutralize or react with some of these critical important signaling oxidants, such as hydrogen peroxide, singlet oxygen, superoxide radicals and nitric oxide. It just does not have the ability to react with these, even in vitro, even if you just put the two together, they don't react.

Dr. Mercola:

What's the current thought on hydroxyl free radical? Because I think, initially, that was the consideration. There was this mechanism of action. It was neutralizing this free radical, but I don't believe that's the current thought.

Tyler LeBaron:

Yeah, and that's probably right because there are so many discrepancies about that, but you're right. Initially, it was considered, "Well, hey, if hydrogen gas, it can, one of the very few free radicals of hydrogen gas can react with is the toxic hydroxyl radical." The hydroxyl radical is literally the most reactive radical in the body. It has such a strong oxidizing power and potential that it reacts indiscriminately with anything instantaneously, and it's so strong, it has such a strong oxidizing power, that it actually can react with hydrogen gas, and when it does, you create simply water, which can be nice, right?

Tyler LeBaron:

Because hydrogen gas is able to distribute throughout the body so quickly, and because it's so small, then during the times of, say, a trauma. So if you consider, say, a cerebral infarction, a stroke, where you have these conditions of ischemia reperfusion, which to talk about that, the ischemia part is when you have the lack of blood flow to, say, your brain, and that causes lots of damage. Of course, if you don't get blood flow soon enough, then if you have no oxygen and no nutrients, then that tissue, those cells, will die.

Tyler LeBaron:

Interestingly, even more damaging than a short-term ischemia is the reperfusion process, which is when you bring back in the oxygen-rich blood into those cells and to the organ. When you do that, that creates a cascade of all these oxidative and inflammatory responses, and the sequela of all these events leads to necrosis, and apoptosis, and death, and everything.

Tyler LeBaron:

That's why, for example, people who suffer from a myocardial infarction or different areas, sometimes they can be resuscitated, and then days later they end up dying or they end up having a severe damage because, yeah, they saved them immediately, but the long-term effects ended up being very damaging. Okay.

Tyler LeBaron:

So, this is a critical aspect of how molecular hydrogen could work during these times of ischemia reperfusion or other issues is because during that time, there are a whole bunch of hydroxyl radicals that are produced, and hydroxyl radicals are just so damaging and lethal, and then hydrogen gas, because it's such a small molecule, it can rapidly diffuse there. They would react to hydroxyl radicals, prevent the damage and there you go.

Tyler LeBaron:

We see the benefits of hydrogen gas appears to almost be doing just that because that first article that you and I talked about in Nature Medicine published in 2007, that's exactly what they found when they induced it, this ischemia reperfusion in the brain by cutting the blood supply to the brain, and then they inhaled hydrogen gas. Well, they wrote a study and they administered 2% hydrogen gas.

Tyler LeBaron:

That 2% hydrogen gas significantly suppressed the brain damage induced by this cerebral infarction, basically. It was thought, "Well, hey, that's probably because it's able to get through there where all

these hydroxyl radicals are being produced, quenched all those bad guys and now we don't have that damage." To your point, maybe that's not really what's going on.

Dr. Mercola:

Well, let me stop here because I think that is an important consideration that you're bringing up that I seem to have neglected, but it would appear that part of the revised protocol for every heart attack, at least acute heart attack and stroke should have molecular hydrogen implemented ASAP because of the ischemia reperfusion injury prevention potential. Has there been studies that looked at this or are there any protocols being deployed currently because it would seem it's the perfect marriage for this. I mean, why would you not do it? There's no risk. The cost is almost free, and the upside potential is enormous.

Tyler LeBaron:

Yeah. Absolutely. Fortunately, there are some research programs that are getting into place with this because the animal models have been very, very promising. In fact, one study, for example, on a rodent study, just consider these numbers as I tell them with post-cardiac arrest syndrome. With no treatment at all, there was only a 43% survival, okay? So, that's pretty grand, 43% survival.

Dr. Mercola:

Almost 1 out of 2 are dead.

Tyler LeBaron:

Yeah. Exactly. Right? Now, when they do the standard therapy, which is therapeutic hypothermia – cool the body down because that's going to lower the metabolism – and that's going to create less free radicals, so it works very well. In fact, so well that the survival rate goes from 43% all the way to 77%. So, obviously, that's why it's often done.

Tyler LeBaron:

Now, when they used hydrogen gas, just hydrogen gas alone, that survival rate went to 92%. Then when they combined it, it was 100%, 100% survival, okay?

Dr. Mercola:

That's exactly where I would project it. I didn't know the studies were done, but that is just awesome.

Tyler LeBaron:

Yeah.

Dr. Mercola:

It's almost free. I mean, it just literally costs far less than a dollar to implement that therapy.

Tyler LeBaron:

Yeah. It really is pretty easy. Now, again, that was just a rodent study. There are quite a few rodent studies that are coming out. There are studies that's been done in pigs. In fact, we did some research in Prague last year with inhalation during heart transplants. We're still analyzing the data, but we saw some good effects, decreased in oxidative damage and things. There was also a study done by Harvard

University published in the American Heart Association Journal. They found some phenomenal effects using hydrogen gas for extracorporeal blood circulation.

Dr. Mercola:

Yeah. Well, that is just fantastic. I wasn't expecting to find new indications I hadn't appreciated before, but that is good. I interrupted you and took you off on a tangent. You were going to explain the, I believe, mechanism now because the primacy mechanism is not hydroxyl even though it has great benefit in that for these two acute problems. These are not small considerations. Stroke and heart attack are the leading cause of death in the United States, so that people know, meaning this is what takes most people up.

Tyler LeBaron:

Yeah. That's right. That's right. I was distracted, but I forgot to tell you the most important aspect of all of this, the Japanese government actually approved the inhalation of hydrogen gas as an advanced medicine for the treatment of post-cardiac arrest syndrome.

Tyler LeBaron:

So, now, there's a major study going on, 360 patients in multi-hospitals looking to really determine the true efficacy of inhalation of hydrogen gas during these exact conditions that we're talking about. So, that's going on in Japan, and there are some clinical studies that have already come out showing very favorable effects. I mean, not as much as the rodents. It's very difficult to have the exact same amazing effects in rodents as it in humans, but the fact that you're seeing translational effects, which almost, I mean, it almost never occurs with typical supplements and pharmaceuticals, but we're seeing these promising effects in human.

Tyler LeBaron:

Then with that Harvard study, for example, now, they actually have obtained approval from the FDA as an investigative new drug to do a similar type of research during extracorporeal blood circulation to actually use hydrogen gas during this period as well. So, this is an ongoing thing that appears to just continue growing with more research groups from different places looking at it more.

Tyler LeBaron:

Initially, again, that hydroxyl radical, it is a very major contributor to the damaging effects that occur during ischemia reperfusion. That's why almost every article, especially the earlier articles that you look at on hydrogen gas, it talks about the hydroxyl radicals and a major emphasis on ischemia reperfusion.

Tyler LeBaron:

As we were talking about, well, maybe the hydroxyl radical is not as biologically significant that the scavenging activity of the hydroxyl radical is not as biologically significant as we thought it was before.

Dr. Mercola:

Well, listen, individuals who aren't dying acutely from a severe stressor.

Tyler LeBaron:

Right. Yeah. Exactly. Yeah.

Dr. Mercola:

Normal humans.

Tyler LeBaron:

Yeah, those who don't have a huge bout of hydroxyl radicals that have already oxidized all the antioxidants and everything else already, right? The fact is that when you do the chemical kinetics, and I've done quite a bit of math and things on this looking at the second order rate constants, and the fact is hydrogen gas to react with hydroxyl radical, the rate cost is about three times lower or is a magnitude lower than it is for other nucleophilic molecules that would react to hydroxyl radical.

Tyler LeBaron:

So, when you just do some of these calculations, you start seeing that despite hydrogen gas being able to diffuse very quickly and get to these places very easily, the hydroxyl radical just reacts so fast that the probability, just to base on probability for it to actually interact and intersect with each other, is quite low. So, something else has to be going on.

Tyler LeBaron:

In fact, even with these ischemia reperfusion studies, if we were to administer hydrogen gas, say, hours before, and then hydrogen gas is only going to stay in the body for, say, an hour, okay? Then after all the hydrogen gas is gone out of the body and then there's an ischemia reperfusion attack, an IR, ischemia reperfusion, IR injury, you still see a very pronounced benefit from previously administering hydrogen gas despite the fact that there was no hydrogen gas present in order to scavenge these hydroxyl radicals. So, how do you explain that then, right?

Tyler LeBaron:

So, this is why it's a recognition that hydrogen gas, clearly, it's role is much more than just acting as this typical antioxidant, but truly acting as a gaseous signal modulator that is able to influence gene expression, protein phosphorylations, signal transduction cascades, all of these things that help explain the therapeutic effects we're observing from hydrogen gas.

Dr. Mercola:

Yeah. Is that primarily done through the Nrf2 pathway?

Tyler LeBaron:

I will say yes. So, the antioxidant effects of hydrogen gas is probably one of the main things. So, we should probably talk about the Nrf2. Again, the Nrf2 is this protein that's bound, it's in the cytosol bound to another protein KIP1, and when there's an assault of oxidative stress or something, then those two separate, and then the Nrf2 is able to diffuse into the nucleus of the DNA and it binds to the electrophile response or AR, the antioxidant response element portion of the DNA.

Tyler LeBaron:

When it does that, that ends up leading to the production of a whole bunch of endogenous antioxidants like your glutathione, superoxide dismutase and catalase. In fact, they don't have two regulates and controls over 200 cytoprotective proteins and enzymes. That's why it's called a phase II detoxification enzyme.

Tyler LeBaron:

So, when we talk about antioxidation and detoxification and all of this stuff, a lot of that is all regulated and controlled by Nrf2. That is the master regulator. So, it is a key protein involved in all of the cellular processes. It turns out hydrogen gas is able to activate the Nrf2 pathway.

Dr. Mercola:

Now, how would you compare to some of the xenohormetic activators of Nrf2 like sulforaphane, which should be, I think, classically considered one of the most powerful, powerful activators?

Tyler LeBaron:

Yeah, well, I guess, for me, I wouldn't compare it because-

Dr. Mercola:

Okay.

Tyler LeBaron:

I mean, you can do one study and you can directly compare the two, but that's looking at the cell culture or something. That's not going to give you the indication of what's really going on because the pharmacology of the two are totally different. Hydrogen gas, in fact, hydrogen gas may not – if the cell is already normal and it already has the correct cellular homeostasis, and there's not an excess amount of oxidative stress going on, you might find that there's no actual increase in downstream Nrf2 proteins that have been activated because you already have normal levels of, say, superoxide dismutase or catalase.

Tyler LeBaron:

You don't want to have higher levels. You might see increase in mRNA production of Nrf2, but just because you see higher mRNA – so, mRNA is the messenger RNA. So, you have to have your DNA and then you make mRNA, and then mRNA is used to then make the proteins. So, it has to go through this process.

Tyler LeBaron:

So, you can have an increase in mRNA, but just because you have an increase in mRNA does not necessarily mean you're going to have an increase in proteins. So, sometimes hydrogen gas increases the mRNA levels, but that doesn't always mean that, well, a lot of it that's hydrogen gas, but just because of higher mRNA levels does not mean you're going to have higher protein levels because those are further regulated.

Tyler LeBaron:

So, the point is, whereas with sulforaphane or some other things, you almost always see a spike and increase in the Nrf2 production, where with hydrogen gas, you may not necessarily see that because it may not be needed.

Dr. Mercola:

So, that's the primary distinction, is there is no endogenous biofeedback with sulforaphane. It's just pressing the accelerator Nrf2 indiscriminately. Whereas Nrf2, you've got this endogenous control system that only produces it if it's necessary.

Tyler LeBaron:

Yeah. That's probably a good way to think about it. That's one of the nice things about hydrogen gas, [it] really decreases its risk for being toxic to the cells because it doesn't have the capacity to just go in indiscriminately and just force the production or induction or something of the Nrf2 or a whole bunch of other molecules that it's able to regulate.

Tyler LeBaron:

It tends to bring things back to homeostasis. The further something is away from homeostasis, the higher the probability that hydrogen gas will be able to help bring that back into homeostasis. As something that's already at a perfect level, well, then, you may see that hydrogen gas didn't do anything for that to maintain that perfect level.

Dr. Mercola:

Why don't you have a few other comments on the safety profile? It appears to be one of the safest therapeutic options that's available to humans, and toxicity is almost nonexistent. So, why don't give a few examples that support that supposition?

Tyler LeBaron:

Yeah. Absolutely. So, hydrogen gas, because it's not just such a strong pharmacological agent, that means that it's not going to – it's not like an NSAID, nonsteroidal anti-inflammatory or a steroid or something where you're going to have this dramatic effect. Things that have dramatic biological effects often are going to have very toxic effects when taken too much or too high. The smaller the effect, the less likely it is to have a toxic type effect.

Tyler LeBaron:

Although, anecdotally, there are people when they take the molecular hydrogen, they notice a very quick relief of, say, pain or different things, which we can talk about that later.

Tyler LeBaron:

The fact that hydrogen gas is a very mild molecule that tends to regulate things back towards homeostasis helps it to be a safer molecule. So, when we look at the studies done on molecular hydrogen, we can see the safety from several different angles.

Tyler LeBaron:

Number one, if we look at research from deep sea diving. So in deep sea diving, typically, often they use helium gas because that's not very narcotic compared to nitrogen gas, but when they go really deep, sometimes they'll even use hydrogen gas like hydreliox or hydroxy even, which is 98% hydrogen gas, and they can go very deep because hydrogen is less narcotic than any of the [other] gases, and these pressures were talking about are extreme, extreme pressures that there's no way you could ever – I mean, we're talking about 10, 20 atmospheres of pressure. They've done the studies, these human

studies with 19 ATM (atmospheres) [inaudible 00:32:58] of pressure and the balanced oxygen. So, there's actually still the same amount of oxygen available on a mole basis.

Dr. Mercola:

God! They've had to do with it hydrogen because the oxygen toxicity at that pressure is just enormous. You'd go into a seizure and die.

Tyler LeBaron:

Yeah. Exactly. Yeah. So, they have lower it down so there's the same amount of molecules under that pressure, right? When they do these studies, there's no long toxic effects of the hydrogen gas. So, despite the fact that very high pressures, we don't see any long-term toxic effects. Interestingly, there's some of these people who've been doing deep-sea diving for a long time, when you go down there really deep, you get this deep-sea diver-type anxiety, kind of a sickness, where you start being quite scared, basically.

Tyler LeBaron:

Hydrogen gas also has this biological effect to slightly suppress that anxiety, so that you can think better and be more calm and be clear. So, it has this other effect that deep-sea divers have known for a long time and never really understanding why or maybe we're understanding a little bit more because now we understand the biological effects of hydrogen gas.

Tyler LeBaron:

So, the first line of safety simply comes even from the studies done since the 1940s in deep-sea diving. Then we have other studies. Well, actually, another big one is the fact that hydrogen gas is a natural molecule to our body. It's not some alien or foreign substance that our body has never been exposed to. We're exposed to hydrogen gas on a daily basis from the bacteria in our intestines that are producing it all the time. So, we're always exposed to hydrogen gas.

Tyler LeBaron:

So, when you eat your fibers, your non-digestible carbohydrates, and your fruits and your vegetables, a lot of that fiber can then be metabolized by the bacteria in your intestines to produce hydrogen gas, and then you have hydrogen gas in your blood and in your breath. There's quite a few studies demonstrating that this hydrogen gas is, indeed, therapeutic and it has therapeutic effects.

Tyler LeBaron:

By blocking the production of hydrogen gas, despite still giving it fiber, a lot of those benefits are eliminated or at least significantly reduced. In fact, some of them suggested that some of the drugs like acarbose or different things that have cardiovascular protective effects may have something do with the fact that more hydrogen gas is being produced.

Tyler LeBaron:

So, again, about the safety of deep sea diving, you have the endogenous production from the body, and then you have the actual studies that we've been conducting whether in human clinical studies or in animal studies or in cell culture studies, where we've taken at a cellular level, taken the concentration of hydrogen gas to, let's see, if there's 20 micromolars, so 10 times, 100 times higher than you would ever

get by taking hydrogen gas any other way, and we see it in the cells that there's no toxic effect. So, this is a very big issue of benefit with the safety of hydrogen.

Tyler LeBaron:

Now, one interesting thing, though, is maybe hydrogen gas does have a toxic effect, and that's why it induces this hormesis effect because how does hydrogen gas activate the Nrf2 pathway? In order for hydrogen gas to activate Nrf2 pathway, it has to be doing something that causes the cellto be like, "Wait. Something is not quite right. I don't know what it is, but I'm just going to activate these cytoprotective proteins just in case."

Tyler LeBaron:

So, hydrogen is doing something, but when you look at the studies, so for example, in one study, they administered hydrogen peroxide to the cells and that both can kill the cells, as well as it can activate the Nrf2 pathway.

Tyler LeBaron:

When you administer the hydrogen gas with the hydrogen peroxide, the cell survival increases because hydrogen gas is protecting it. So, somehow, if hydrogen gas indiscriminately activated an Nrf2 pathway, then you would actually see that if you administer hydrogen gas, sorry – if you administer hydrogen peroxide, a toxin, and then you administer hydrogen gas, which also would ostensibly be a toxin because it can activate the Nrf2 pathway, then you would expect to see more cell death, but that's not what you see. You see an increased cell survival.

Tyler LeBaron:

Then when you administer hydrogen gas alone rather than hydrogen peroxide, you can still see an increase in the Nrf2 pathway. So, again, hydrogen gas has this dual role where it can both protect against the oxidative stress, as well as act as this mild hormetic effector in the mitochondria to increase mild amounts of free radicals, similar to an easy bout of exercise, for example, which can then induce these protective effects.

Tyler LeBaron:

So, there might be a toxic effect, but it's so small and for such a short amount of time that that is what mediates the benefits of hydrogen, and then by the time you build up hydrogen and everything else, you never actually get a really toxic effect of hydrogen because the fact is hydrogen gas does not build up in the body. You just exhale it out. It's gone within an hour after ingestion.

Dr. Mercola:

We'll talk about the dosing next. I just want to make a comment first and repeat a comment I made in the first interview that we had, which was an experience I had during my residency program, which was an inner city hospital. There were many end-stage alcoholics there and a number of whom had hepatic encephalopathy essentially because their liver was shot. They were in a brain coma.

Dr. Mercola:

One of the treatments at that time, and I think still may exist, I haven’t practiced that type of medicine for many decades now, but it was lactulose, which is a non-digestible carbohydrate, which is fermented

by the – at the time, I didn't know this, but it was fermented, and I don't think anyone knew how it worked, but it worked. I mean, if you give these patients lactulose, they would come out of the coma.

Dr. Mercola:

It appears to generate increased hydrogen gas production by the bacteria in the gut because it's fermented by them, and boom, activates the Nrf2 pathway, and they're rescued. It's just extraordinary, and a simple, inexpensive and nontoxic solution.

Tyler LeBaron:

Yeah, yeah. Thanks for bringing that up. Yeah. Lactulose is great. It really does increase the production of hydrogen a lot. There are specific studies that have been done using lactulose showing the benefits are mediated by hydrogen gas, but we don't understand if that's all of them.

Dr. Mercola:

Yeah, but ultimately, it's this hydrogen gas. So, people might be wondering if they're not familiar already, how do you get hydrogen gas? The obvious ways are that you can inhale it, and as you mentioned, they are doing this in many studies in Japan to see the benefits, but that has its downsides because, well, you can talk about how it's administered from inhalation, but it's not easy, and it's not simple, and there's a lot of complexity to it.

Dr. Mercola:

The other way is to dissolve that gas in water and drink it, which is a lot easier to do through a tablet mechanism. Of course, you can make it with electrolysis machines, which are a lot more expensive and don't produce anywhere near the concentrations that you would require.

Dr. Mercola:

So, I think, why don't you discuss those? Then, also, the really crucial concept here that needs to be understood at a very deep level in that it's not just, and it's counterintuitive because you would think the more hydrogen gas, the better, but that's not the case because as you mentioned, we're making 10 liters of hydrogen gas a day. That's a lot of hydrogen gas, but it's not the absolute quantity that's important. It's the pulsing or the acute elevation over a short period of time that seems to stimulate the Nrf2 pathway. So, help us understand that at a deeper level.

Tyler LeBaron:

Yeah, sure. So, okay. So, I guess we'll focus on that intermittent type of exposure and the dosage.

Dr. Mercola:

The gas in different ways, comparing the inhaled gas to the tablets.

Tyler LeBaron:

Okay. Maybe, yeah, we'll just go through that then. Okay. So, yeah, with inhalation, yeah, absolutely. When it comes to medical gases, we're used to administering gas through inhalation. It seems almost strange to take the gas and then dissolve it into water and then drink it like oxygen. That's one of the biggest scams in the industry, in the world-

Dr. Mercola:

Oxygen water.

Tyler LeBaron:

Oxygen water, yeah, taking oxygen, dissolving in the water, and thinking that if you drink that you're going to get all these benefits.

Dr. Mercola:

It's not going to work, folks.

Tyler LeBaron:

Yeah. It doesn't work. There's the low solubility. The oxygen is absorbed in the lungs because that's where the high pH with the Bohr effect. It's all this other kind of stuff.

Dr. Mercola:

Yeah, it binds to hemoglobin and it doesn't dissolve in plasma spontaneously, unless you want to a hyperbaric chamber.

Tyler LeBaron:

Yeah, yeah, which is different. Exactly. Yeah. The fact is, you would get more oxygen in your body by breathing an extra quarter of a breath, if you will, in a couple of minutes than you would by drinking water. So, yeah, exactly, it doesn't work.

Tyler LeBaron:

So, it really is strange and we're saying, "Yeah. You can take hydrogen gas – also a gas – and dissolve it in the water and drink it and get benefits." What's the difference? Because if you can't do it with oxygen, then how are you doing it with hydrogen? Hydrogen also doesn't have high solubility.

Tyler LeBaron:

In fact, the solubility is only 1.6 milligrams/Liter (mg/L). So, that's not very much. How can this even work? But the fact is it does work. We'll explain some differences between oxygen and hydrogen and why the hydrogen method in water would work whereas the oxygen will not work.

Tyler LeBaron:

Of course, with inhalation, yeah, the studies are very favorable when it's coming to using inhalation, but it's interesting in like a Parkinson's disease animal model where they used inhalation of hydrogen gas 24/7. So, 24/7 exposure. The cages were exposed to hydrogen gas for 24/7, about a 2% to 3% hydrogen concentration.

Dr. Mercola:

Just as an aside, this is because over 4%, it becomes explosive.

Tyler LeBaron:

Correct. Yeah. Exactly. Yeah. That's one of the great things about hydrogen. Even at a level below the inflammability level, it's sufficient to be therapeutic, right? So, they had 2% to 3%, and then they had another group [where] they inhaled hydrogen gas intermittently, so once every hour for a few minutes, 15 minutes. Then another group actually was given lactulose, which produces a lot of hydrogen gas. Then the third group drank hydrogen water. At the end of the study-

Dr. Mercola:

Were they drinking the water continuously?

Tyler LeBaron:

Just normally, ad libitum, whenever they drink water.

Dr. Mercola:

Ad libitum.

Tyler LeBaron:

Yeah. Exactly.

Dr. Mercola:

How do they keep it dissolved in the water, though, because it diffuses up pretty quickly?

Tyler LeBaron:

Yeah. You just have to change it several times a day, at least twice a day, and it's also special the way they did it with aluminum foil and decreasing the head space. There are different ways that the researchers have been able to keep a high enough concentration by the time they change the next time that the loss is not too great, right?

Tyler LeBaron:

What they found, though, was that the continuous hydrogen administration, so 24/7, you're getting the most hydrogen because you've always been exposed to it – had no effect. There was no benefit.

Dr. Mercola:

None. Totally counterintuitive.

Tyler LeBaron:

Yeah, especially if we talk about the scavenging of hydroxyl radicals. Well, then if hydrogen gas is always there and always present, you'll be able to scavenge whatever radical. Boom, it's gone. Well, there was no benefit, okay?

Tyler LeBaron:

Then when they did intermittent exposure of hydrogen, so intermittent inhalation, there was a benefit, statistically significant, but not fantastic. Then with the lactulose administration, actually, there was no benefit either.

Dr. Mercola:

Because it's continuous.

Tyler LeBaron:

Yeah, probably because it was continuous. Now, other studies like I said, there are other studies showing that lactulose administration produces hydrogen gas did exert very therapeutic effects. So, there are different disease models, and this was a Parkinson's disease model. In this case, it didn't have benefit.

Tyler LeBaron:

Now, despite that the intermittent inhalation was beneficial, it was nowhere near as beneficial as the drinking of hydrogen water, okay? So, we do see that, obviously, drinking hydrogen water has its place. In some cases, it could be more effective than inhalation.

Tyler LeBaron:

Now, again, that still has the very big question, "Well, yeah, but hydrogen gas in water? That's the same problem with oxygen. What's the difference? How in the heck can you have hydrogen work but oxygen water does not work?" That's because it's an apple-to-orange comparison. Oxygen, you have to get – we actually literally use oxygen and quite a bit of the atmosphere is 21% oxygen, and we use at least 5% of that every single time that we breathe, which actually is not a lot, but we use about 5% of the oxygen per breath that you take in, but you're actually using this, and it's transported by hemoglobin, and all of this kind of stuff.

Tyler LeBaron:

Well, hydrogen gas, when you drink it, there are a couple of things to consider. Number one, yes, 1.6 mg/L as a solubility doesn't sound very much because you're like, "Hey, I take 100 mg of vitamin C. So, 1.6 mg, how can that be very much?" Don't forget that hydrogen gas is the lightest molecule in the universe, okay? So, of course, 1.6 mg doesn't weight very much because it's hydrogen gas. It, of course, doesn't weigh very much, but it's actually a lot of molecules. In fact, there are more molecules in 1.6 mg of hydrogen than there are molecules of vitamin C in a 100 mg dose.

Dr. Mercola:

That's a very good point. Thank you for helping us understand that.

Tyler LeBaron:

Yeah. You have to compare molecules to molecules or moles to moles not just weight to weight. What weighs more, a pound of gold or a pound of feathers? Right?

Dr. Mercola:

They weigh the same.

Tyler LeBaron:

They weigh the same, right? So, intuitively, we're like, "Of course, the gold is going to weigh more." It's the pounds. Exactly. So, when we look at molecular hydrogen, there is actually quite a bit. The fact is

that there are many molecules that work in the body at biologically relevant concentrations in the nanograms, only taking the nanogram level. So, actually, 1.6 mg is plenty.

Tyler LeBaron:

Now, get this. When you inhale, say, a 3% hydrogen gas, then that's going to increase the cellular concentration to a certain level, okay? Now, that exact same level, if we can calculate it based on Henry's law and the dose you're ingesting from drinking hydrogen water, that concentration in the cell can also be reached by just drinking hydrogen water because if you drink all of it at once and it goes into the body and immediately increases the cellular concentration to the same level that you would get if you were inhaling hydrogen gas at 2% or 3% level.

Tyler LeBaron:

So, of course, they're not going to be there as long because when you're inhaling, you're typically inhaling for a longer period of time. In fact, we did do a study in Parkinson's disease in humans, where we tried to mimic the temporal profile of hydrogen gas in the body, and it was a short study, but they only inhaled a very small amount, a very small percentage of hydrogen gas for, I think it was 10 minutes, because they're trying to closely mimic the amount of hydrogen gas you would be getting if you were to drink hydrogen water.

Tyler LeBaron:

We saw two interesting effects. Number one, we saw no statistical benefit. So, it doesn't work that way. We didn't see any benefit to the disease model. Maybe if we would have gone longer, we would have seen something, I don't know, but we did see something was happening because we saw mild increases, similar to what you would see with a bout of exercise, of oxidative stress.

Tyler LeBaron:

So, something was happening. Something in the body was getting to change. So, I could say maybe if we would have continued the study, we would start seeing some benefits with that. In this case, with the short-term very small amount of hydrogen, we didn't do it.

Tyler LeBaron:

Now, one of the differences also could be because the benefits of hydrogen gas to the Parkinson's disease, there's some data that suggest that it is partly mediated by ghrelin, which is a hunger hormone, a gastric ghrelin release drinking hydrogen water. The oral consumption of hydrogen water can induce gastric ghrelin release, and the ghrelin acts as a second messenger to benefit the brain. Inhalation of hydrogen gas may not have actually enacted that signaling molecule.

Tyler LeBaron:

So, going back to this concept, drinking hydrogen water all at once increases the cellular concentration to the same level as inhaling does for a shorter period of time, but it just, boom, right there, you get a very fast concentration, and then you're also able to enact various second messenger systems that maybe you're not getting with inhalation.

Tyler LeBaron:

So, there are, obviously, cases where drinking hydrogen water is more effective than inhalation, and probably vice versa as well. We need more research on that.

Dr. Mercola:

Yeah. An important distinction is that you are referencing the normal solubility of hydrogen in water, which is 1.6 mg, but there are tablets that create these nanobubbles, which capitalize on Henry's law, and through these pressure differentials are able to increase their concentration to up to 8 mg/L, 9 mg/L and 10 mg/L, which is literally almost 10 times more. So, you would expect a better result with a higher concentration over the similar duration.

Tyler LeBaron:

Some things are suggesting that as well, So, we actually used those tablets in some of our clinical studies we did.

Dr. Mercola:

Oh, you did?

Tyler LeBaron:

Yeah. So, we actually found one of them, we did with a nonalcoholic fatty liver disease. Okay. Maybe we should back up. This is also interesting. We talked about this before, but just to consider about dosing a little bit, back in 2013, I was contacted by a group who was doing research on alkaline ionized water, and they were trying to look at the benefits of alkaline ionized water on fatty liver disease induced by high-fat diet. They found no benefit, no benefit whatsoever despite other articles showing the benefit.

Tyler LeBaron:

I started talking with them, "Well, what is the concentration of hydrogen?" They had no idea. They didn't know because that didn't seem to be an important part in alkaline ionizing water research at the time.

Tyler LeBaron:

So, I said, "Okay. We need to figure what that is." So, I taught them how to measure the concentration of hydrogen, and they were able to do that. It came back and the concentration was 0.3 mg/L or so.

Tyler LeBaron:

Then they decided to, "Let's do the study again, the exact same study, but let's do a low dose of hydrogen and a higher dose of hydrogen." So, the lower dose, again, about 0.3 mg/L and the higher dose closer to 1 mg/L. So, still not even very high, right? That was the ability that we have again many years ago to make the hydrogen water for the rodents.

Tyler LeBaron:

Now, what they found is that the low dose, again, had no benefit. There was no benefit compared to just normal control, normal tap water. It was the same as the alkaline ionized water, right? So, despite having the negative ORT that they talk about, the alkaline pH, all those kinds of stuff, there was no benefit, but the group that had the higher amount of hydrogen gas and it was a neutral pH or close to

the neutral – I have to look at the study again. I think it was actually slightly alkaline because of the way we made it.

Tyler LeBaron:

Anyway, it was the hydrogen gas and it exerted a very prominent effect on the non-alcoholic fatty liver disease. So, when we do that, the dosing conversion, because mice drink a lot of water. In fact, they drink the human equivalent for – we'd be drinking 10 to 12 liters a day of water if we were mice. So, all the water that mice are drinking is hydrogen water.

Tyler LeBaron:

So, with us, if we're only drinking, say, half a liter or a liter of hydrogen water, well, then we're getting 10 times a lower total dose of hydrogen. Does that make sense?

Dr. Mercola:

Sure.

Tyler LeBaron:

So, with this clinical study that we published for nonalcoholic fatty liver disease, and we used some nuclear magnetic resonance imaging technology to look at the fat deposits in the liver and things. We used the hydrogen-producing tablets at high concentrations, and found-

Dr. Mercola:

9 mg or 10 mg?

Tyler LeBaron:

Yeah. Exactly. Yeah, the same ones. We found, it's a very short study, only 12, yeah, I think we had 12 subjects, but it was very, very obvious that hydrogen was having an effect even with the subjects. So, again, suggesting there's a higher concentration of hydrogen.

Tyler LeBaron:

Now, there's another article that should be published shortly, but I'll mention briefly on metabolic syndrome. Most studies have used a rather low dose of hydrogen, so a milligram of hydrogen per liter drinking, say, a liter of water. Then in this case, we decided to increase the dosage at very high levels using the hydrogen-producing tablets, and we used 60 subjects, and we went for 24 weeks. So, six months-long study.

Tyler LeBaron:

It appears that we had some very prominent effects, and even more effective compared to the previous studies leading to this trend that at least in some cases, a higher dose or a higher concentration of hydrogen is more effective than the lower dose, lower concentrations. That should make sense when we consider the very favorable effects we see in animal studies.

Tyler LeBaron:

Well, one of the issues is the animals are getting 10 times more hydrogen total because they're drinking so much more water than we are.

Dr. Mercola:

Okay. So, thank you for sharing that, helping us understand that the quantity does make a difference if it's done strategically in pulse and cycled. So, it's very clear that a higher dose seems to work better, but the real second essential and important question is, "What is the dosing? What is the cycling? Is it once a day? Is it twice a day? Is it once every other day?" I mean, how long of a rest do you need before you take the next dose to still get optimal benefits?

Tyler LeBaron:

Yeah. I don't know. We need to figure that out because the fact is, like I said, the hydrogen is going to be gone in the body within an hour, okay? So, it is possible, it's possible, you could drink hydrogen water let's say every hour, and by doing that, it would spike and it would go back down, spike and go back down. Maybe that will be more effective or maybe that will be less effective than drinking it just once or twice. You'll only get the spike once or twice a day.

Tyler LeBaron:

We really need more research on that, but I will say, let's do some other comparisons, right? So, let's say they're going to take a total of 10 mg of hydrogen, okay?

Dr. Mercola:

Hefty dose. Hefty dose.

Tyler LeBaron:

Yeah. Actually, let's say 6 mg of hydrogen because I want to use a different analogy, 6 mg of hydrogen, and you're going to take all 6 mg evenly in a 24-hour period, right? So, that means you're essentially sipping on hydrogen water.

Dr. Mercola:

A quarter of milligram an hour.

Tyler LeBaron:

Exactly. Yes. Exactly. That's what you're doing, right? So, you're sipping on hydrogen throughout the day. Now, if you do that, you may not get as good of benefits because you're not getting a high enough dose of hydrogen in the body in order to reach the cellular concentrations required in order to induce those benefits and those changes at the cellular level that we require, that we need.

Tyler LeBaron:

Now, if in contrast, if you were to just take all that dose, the full 6 mg all at once, that is probably going to be more effective, taking it all at once than taking it throughout the entire day. So, I will say if you are going to get hydrogen and try to get the benefits, then you would want get as high of a dose you can all at once, and then you could probably do that multiple times a day, I imagine.

Tyler LeBaron:

So, like I said, I don't know if it's better to take it just once a day, take 6 mg or 10 mg of hydrogen once a day. Is that better than taking 6 mg or 10 mg six times a day? Maybe the six or 10 times a day is going to

be more effective or just as effective because you're still getting at a high enough level. You're still getting spikes. You're still getting all those different things, but then again maybe not.

Dr. Mercola:

Someone's got to do the darn studies. In the interim, until then, it would seem that customizing the dose to your personal circumstances might be more appropriate. So, if you're in a normal, non-stressful circumstance at home, not really doing anything very stressful, not exercising much at all. Maybe once day is sufficient, but if you're a madman like you are with your exercise, then you're going to want to take it to help reduce the oxidative stress from your intense exercise or if you're traveling and exposing yourself to free radical stress from ionizing radiation at 35,000 feet. Then you might be more appropriate to take it every two hours while you're flying. What do you think about that strategy?

Tyler LeBaron:

I like the strategy of the fact that, "Try it out." I mean, because hydrogen gas alone is really quite safe, then you're free to really take quite a bit of it at different times to see the effects from that. I mean, yeah, you might try multiple times a day for a little bit, and then maybe just try it once a day for a while. Just taking one – I guess when we're talking about the tablets because there are other hydrogen waters out there. You just have to make sure you give them the right dose, but at least with the tablets, you know that just by taking one tablet, you're getting at least as much hydrogen gas as used in the majority of clinical studies. So, now, that's the daily maintenance.

Tyler LeBaron:

Then if you're going to fly like you said or you're going to [do] pushups, really hard exercise or maybe you're battling with some condition, maybe I suppose, yeah, because hydrogen is safe, you could bump it up a little bit more and try the other-

Dr. Mercola:

Yeah, the other benefit, too, with oxidative stress I had neglected to mention is that mechanism these tablets are able to produce hydrogen is that it actually use very pure grade of metallic magnesium. The magnesium dissociates into magnesium ions. It's not a compound. It's not bound to anything. So, it's absorbed very readily. It's not insignificant quantity. It's 80 mg of elemental ionic magnesium, which is basically 20% of the RDA.

Dr. Mercola:

So, that's a very significant dose. If you're taking four or five of them, I mean, you're going to get a massive dose with virtually no risk of loose stools because it's an ion, and you're not going to cause an osmotic diarrhea.

Tyler LeBaron:

Yeah, yeah. That is one of the nice benefits, most for deficient magnesium, anyways. I'm taking [inaudible 01:01:47]

Dr. Mercola:

Yeah, yeah. That's a huge benefit, and you're not getting that benefit if you're getting it from the water generators, which are usually typically they're about a – I mean, you can't really go higher than a normal solubility of molecular hydrogen of water, which is 1.6 mg/L, right?

Tyler LeBaron:

Well, it depends. There are some. There are some that can get relatively high concentrations. They're hit and miss. Then you have the issue with the electrodes. Remember, when that water comes in contact with the electrodes, I mean, hopefully, the electrodes are very gated, platinum-coated, which is very inert, not going to have a problem, but I was in China a few months ago at one of the symposiums and some people did an analysis showing that on some of these units, they had electrode degradation causing heavy metals to be leaked into the water, your cadmium, your lead, your arsenic, different things that can be toxic. So, you just have to be cautious about all these types of things.

Dr. Mercola:

Yeah. So, that's not an issue with the tablets as the simplest, the easiest, and it seems like the no-brainer solution. So, yeah, that's a good way to do that. So, tablets are what I personally prefer. As I said, it's my favorite. It's my absolute favorite supplementation for all the reasons you just described.

Dr. Mercola:

So, I think we've done a good summary, and what I'd like to do now is transition. Maybe you shared most of this as you want to, but I know you're engaged in a lot of cutting-edge research. Part of the intention of this conversation was to get us up-to-date on the newest and most exciting developments in the molecular hydrogen field. So, perhaps you can enlighten us.

Tyler LeBaron:

Yeah, yeah. There are some really exciting things that are going on. Unfortunately, some of them are not – we haven't published some of the results yet. So, some things are still – we had to just be cautious on things that we talk about, but I did mention the fact that Harvard University is moving forward with doing some clinical trials, and that will be really exciting.

Tyler LeBaron:

There are some other universities here in the U.S. that are doing some really neat studies as well. Actually, I think some of them actually using the hydrogen-producing tablets as well.

Dr. Mercola:

Are the Harvard trials on the ischemia reperfusion?

Tyler LeBaron:

Yeah, for extracorporeal blood circulation.

Dr. Mercola:

Perfect, for heart bypass surgery?

Tyler LeBaron:

Yeah, yeah, yeah, or other types of conditions. So, that's really important to understand hydrogen gas. Now, I'm excited. We did a study showing the effects of – what we've done in studies before with the radiation protection in rats, where we iridate the mediastinal area of the rat myocardium, which often can kill the rats, sadly, but cause a lot of necrosis and damage, and different things, and drinking hydrogen water is able to suppress that damage significantly, decreasing marks of oxidative stress like MDA, inflammation, tumor necrosis factor alpha, a lot of different things.

Tyler LeBaron:

This time, what we did is we did a protein microarray analysis, which is really going to be really fast and we're analyzing results right now. So, typically, there's a lot of RNA analysis you can do. You administer the hydrogen or different things, and then you can look to see what types of mRNA changes were made.

Tyler LeBaron:

Now, the problem and I mentioned this earlier, is just because you see changes in the mRNA levels does not necessarily mean you're going to actually have change in the protein levels. Typically, it's very difficult to measure the protein-

Dr. Mercola:

For those who aren't following, the protein levels are the actual endogenous antioxidants that your body is producing.

Tyler LeBaron:

Yeah, yeah. Exactly. Those are the actual proteins, the actual molecules that we need to change transduction to do things. The mRNA, actually, mRNA has a lot of benefits, too. Micro RNA, for example, can regulate [inaudible 01:05:53] translation and things of other things. When you measure protein levels, we typically use, say, the Western blot analysis, which can be quite time-intensive, very difficult, maybe if you only do a few proteins at a time. It's very difficult.

Tyler LeBaron:

Well, we did a protein microarray analysis after hydrogen administration. I mean, we looked at the data. It's just overwhelming. There are hundreds and hundreds of proteins that were influenced and changed by hydrogen administration. Not a whole lot, maybe, but they were changed. You can see the difference.

Tyler LeBaron:

In fact, one of the main people who does this, an expert in this field, he was like, "I don't know if I've ever seen something as dramatic as all of these changes that are made." So, we're very excited to analyze and understand. I mean, they used antibodies to look exactly at phosphorylated levels of proteins because that's the thing. It's not just whether protein was changed, it's about the phosphorylation of the protein because the phosphorylation of the protein is what's going to “how to be active or not active?” and it depends, of course, on what amino acid a residue it's phosphorylated at. That's going to dictate whether it's activated, inhibitory or neutral.

Tyler LeBaron:

So, we're analyzing that data right now, and that's going to really help us understand the molecular mechanisms because the two main things that we really need to understand is, number one, of course, the actual clinical benefits of hydrogen. We're seeing a lot of great pre-clinical and clinical studies that are very promising, a lot of anecdotal reports, but we still haven't proven beyond a shadow of a doubt, if you will, that hydrogen gas is truly this wonder miracle that it appears from, say, the animal studies or people report.

Tyler LeBaron:

We don't know. That takes years and years and lots and lots of research. We do know it's safe, and that's why it's exciting to just keep on studying and studying and to see if it really reaches that criteria of being a mainstream medicine, right?

Tyler LeBaron:

Then besides the clinical effects of hydrogen is really to understand the molecular mechanisms as primary targets of hydrogen gas. So, this work that I'm involved in right now is just it's overwhelming amount of data to try to understand, and this could really help us get an understanding of how hydrogen gas is working because although there are hundreds of molecules and proteins that are being changed, many of those are just passenger molecules that were changed by upstream molecules and drivers.

Tyler LeBaron:

So, we have to look earlier and earlier on in order to see what was the first molecule that was changed in order to induce this cascade of other events and changes in protein phosphorylations and altering signal transduction.

Dr. Mercola:

So, is this study yet to be published? Is it going to be the one that reveals the mechanism of actually how hydrogen gas works or at least suggest the mechanism?

Tyler LeBaron:

Yeah. I think we're getting closer. This specific study is not the one that I had talked to you earlier about, where we think we can see where hydrogen gas can act very, very early on and interacting with part of the cell. I'm being vague on purpose, but-

Dr. Mercola:

Yeah, of course. You have to be because you can't disclose it because it's not published yet.

Tyler LeBaron:

Yeah. Exactly. Frankly, we're not positive. We need to just do more research on this. It does make sense. If we're right, then we can say, “This can happen and this can cause this cascade of events.” It goes right along with our hypothesis on the hormesis effect, and that can be responsible for inducing all these proteins, including the heat-shock proteins we know that hydrogen administration induces heat-shock proteins and upregulates the mitochondria and for the protein response. All of this is about hormesis, and we can see some things very early on that hydrogen may be doing that are responsible for these, and then we see all these downstream effects of molecular hydrogen.

Dr. Mercola:

Yeah. So, one of the reasons why I'm so fond of you is not only are you brilliant as anyone who's listened to this point can really identify this, but you're also really committed to athletic fitness. You're one of the most fit people I know, and really pushed the boundaries of health. So, in that process and in seeking to optimize physical health, frequently, there are benefits to stacking modalities. So, obviously, molecular hydrogen is something you embrace and engage in. I'm wondering [about] some of the other benefits.

Dr. Mercola:

So, it would seem there would be a benefit for syncing, not syncing, but applying these approaches synergistically together. So, I could think of several that I like you maybe to comment on. One would be the sauna with the administration of heat-shock proteins, which you alluded to, and either the creation of ketones naturally through nutritional ketosis or exogenous ketones, and then what was the last one? Oh, hyperbaric oxygen therapy.

Tyler LeBaron:

Yeah. Okay. So, when it comes to the sauna, I think that's great.

Dr. Mercola:

Would you do it together? I mean, from what you know of the mechanism at this point, would you do the hydrogen before the sauna or after?

Tyler LeBaron:

Yeah. I probably would do the hydrogen before anything. That's one of the first things I would do. I say I would because I didn't always do it.

Dr. Mercola:

At least in theory.

Tyler LeBaron:

Yeah, at least in theory. Again, it's talking about this preconditioning hydrogen effect. If I can just back up and talk about one study that you'll find very interesting and I think helps at this stage as well about NAD+ and NADH. Of course, you've done books and all of this stuff on this. These are very important molecules. The higher the ratio of the NAD+ to NADH, the better, and that ratio, not only the ratio, but also the concentration of the molecules themselves tends to decrease with aging.

Tyler LeBaron:

In this one very interesting study, they used a toxin in a cell culture study and administer the toxin to cell cultures, and as would be expected, that ratio decreased, the NAD+ and NADH ratio, and that ends up having all of these pathological problems, and cell death.

Tyler LeBaron:

When you administer the hydrogen gas, it helped to maintain those levels up higher. Now, this is part of the issue, part of the study is they just did it cell cultures, so you can imagine in this little Petri dish, you add hydrogen gas in there. Well, that hydrogen gas will only going to be in there for 20 minutes or half an hour or 40 minutes, depending on the concentration. It's not going to be there for very long. They

found that there was a therapeutic protective effect against that toxin for about 24 hours. It maintained that effect.

Dr. Mercola:

Wow. So, that's suggesting that once-a-day dosing may be a possibility. It's certainly not-

Tyler LeBaron:

-or at least the minimum that you should be doing, right? Take it once a day. But, see, then the other studies, another mesenchymal stem cells, I believe, they went out for administering hydrogen for several, maybe it's a week or so long, then there was still a protective effect for several days later.

Tyler LeBaron:

Then if you want to really go into it, there was the clinical study on rheumatoid arthritis where they had it for four weeks – high-dose hydrogen water. After four weeks, there was still a protective effect of molecular hydrogen. There were still decreases in the disease rating score and oxidative stress even after four weeks. So, it really had an effect on gene expression, epigenetics, signal modulation, something very much more is going on here than, again, just a radical scavenging activity.

Tyler LeBaron:

So, it does appear to slowly but surely slowly improving — I don't know if improving is the right word — influencing that gene expression in a favorable way. So, maybe improving is okay.

Tyler LeBaron:

So, taking these together, when we look at other things such as the sauna, the sauna really is quite a mild thing. I don't know. I suppose there are probably some toxic effects from a sauna, especially if you've been there for too long, just the temperature issue and things.

Dr. Mercola:

Sure.

Tyler LeBaron:

I still like idea taking the hydrogen before. Then when you're talking about your hyperbaric oxygen, then I say I think there's even more rationale of taking the molecular hydrogen before as a pre-treatment, pre-conditioning.

Dr. Mercola:

Before would be at least 30 minutes, maybe an hour, somewhere in that timeframe.

Tyler LeBaron:

Yeah. Exactly. I think that would be ideal. That way, because hyperbaric oxygen, you do get a lot of those benefits, but you do increase oxidative stress. You have different things going on. Of course, a lot of that is what mediates some of the upregulation of DNA, repair enzymes and Nrf2, [which] we talked about. And other things going on, but hydrogen can help to mitigate some of the-

Dr. Mercola:

So, the sauna and the hyperbaric are also hormetic stressors like we believe the molecular hydrogen is, but ketosis doesn't appear to hormetic stressor. It's an alternative pathway. It's an alternative nutrient actually, maybe source of calories that these water-soluble fatty acids that go in there have enormous benefits. There are HDAC inhibitors (histone deacetylase inhibitors). They activate not only Nrf2, but FOXO3, and they increase NADPH, which is another magnificent way to radically reduce oxidative stressors.

Dr. Mercola:

So, have you looked at any studies using them synergistically? It would seem to be a benefit, but I'm just not aware of any that have evaluated that.

Tyler LeBaron:

Yeah. I don't know either. That's probably something that should be looked at. I mean, we can look at some of the pathways that hydrogen gas also is able to activate or optimize. I suppose sometimes when we talk about hormesis is some of it semantics. In fact, some would even argue that hormesis, that ketones, and fasting, and all this stuff is also a form of hormesis. It's not as clear the definition of how we maybe we would like.

Tyler LeBaron:

Some of these pathways that are activated is just some of the benefits. So, for example, with the mitochondria, well, those ketones, whether they're endogenous or exogenous are very beneficial for the mitochondria. As long as the mitochondria are ready for them. Ketones also can increase free radicals at least initially depending on the right places, but this is also what's very good because in the long run, they can decrease oxidative stress. You have a better handle in efficiency of the metabolism of the ketones. Part of this is why you can upregulate the Nrf2 pathway.

Tyler LeBaron:

Well, hydrogen gas being able to both suppress excessive oxidative damage, as well as improve and activate the function of the mitochondria, improving the mitochondrial resting membrane potential. It will have influence in the mitochondria transition pore, so you don't have pathological problems. That's more for the ischemia reperfusion issue, increasing mitochondria biogenesis itself by increasing PGC1 alpha.

Tyler LeBaron:

So, there are some similar areas where ketones seem to work as does hydrogen gas. Then maybe some of data I'm going through right now, we're seeing some phosphorylated levels of various proteins where ketones also influence including AMPK pathway, and a lot of different areas that we can see clearly there are some similar proteins being influenced, but that doesn't necessarily mean it's the one to use.

Dr. Mercola:

So, it's increasing the AMPK levels? That would suggest it would be beneficial in autophagy, too.

Tyler LeBaron:

Yeah. In fact, that's what I'm saying, is just because we see an increase in some of these proteins doesn't necessarily means that's the pathway that's going to occur. So, like autophagy, absolutely yes. Hydrogen does, well, it does, it can induce and actually enhance autophagy. Autophagy-

Dr. Mercola:

Wow! I did not know that. That's beautiful.

Tyler LeBaron:

Yeah. So, we can see increases like Beclin-1 levels, and then NC2, 3, NC3 to 1 ratio, a microtubule, which is autophagy complex, decreased phosphorylations of STAT3, the mTORC1, all these areas that you can have increased autophagy.

Tyler LeBaron:

By so doing, you're going to get therapeutic protective effects from the hydrogen gas. However, there are other studies showing that hydrogen gas inhibits excessive autophagy.

Dr. Mercola:

Excessive autophagy?

Tyler LeBaron:

Yes. Exactly.

Dr. Mercola:

Anything in life, excessive can be bad. There's no question you can have too much autophagy.

Tyler LeBaron:

Yes. Exactly. So, that's how cells die, right? You have necrosis, you have apoptosis, and you have autophagic cell death. When you have too much going on and a lot of drugs or interventions, things can potentially cause an excessive amount of autophagy, then that's bad. Well, hydrogen gas – so for example, what was the compound? There was a drug that was used in a study. I forget, but it induces autophagy too much and it causes a lot of pathological problems.

Dr. Mercola:

Dinitro of something. Any, I forgot.

Tyler LeBaron:

Yeah. Well, I'm not too familiar, but it's still something. Anyway, it was able to prevent the excessive amount of autophagy being produced. Even going through talking about mammalian, what's that? Mammalian target of rapamycin, mTOR.

Dr. Mercola:

Yeah, yeah, simple mTOR.

Tyler LeBaron:

Yeah. Sometimes, yeah, even with this one, maybe hydrogen gas in some cases activates mTOR, which is like, "That's bad," but it's also really good because if you want to recover and get stronger and all of this stuff, you want an mTOR activation. Well, hydrogen gas, it appears in certain cases it could do that. In other cases, you have a lower mTOR. Same thing with IgF1. So, in one human study, IgF1 was decreased by hydrogen. In another, there were some increases in IgF1.

Dr. Mercola:

Well, it depends on where this IgF1 is. Is it in the muscle or is it in the plasma? It has different consequences, though.

Tyler LeBaron:

Yeah. That's exactly right because then you have to talk about, "Okay. What about the receptor sensitivity?" It's a different thing. So, there are so many things to consider. Just because, again, a molecule or a hormone or a protein is increased doesn't necessarily mean it's going to have this direct effect. We have to look at the actual outcomes.

Dr. Mercola:

It's complex. That is great. I did not realize that it influences autophagy because it makes perfect sense because I'm a big fan of time-restricted eating in which case, and that's where I do my exercise, at the tail end of the time-restricted eating. So, I haven't been eating for 18 to 20 hours, then do the sauna, and then I'll eat a big meal, but it sounds like an hour before to do that whole sequence, doing the hydrogen would not only improve autophagy, but then on the tail end of that, activate mTOR for rebuilding muscle protein synthesis.

Tyler LeBaron:

Yeah. It may. I mean, the jury is out. We need to have tons more studies, but that's the nice thing when you think about maybe people who are doing long fasting and they're getting a lot of autophagy. Well, maybe their autophagy stuff isn't going really good in their brain, but they're getting too much autophagy in their kidney, and it's not that simple.

Tyler LeBaron:

The idea then is, okay, so you take hydrogen, then you can continue enhancing autophagy going on in different areas of the body, but attenuate some of the excessive autophagy going on in other places. That's going to make it as long-term, as fast, safer.

Dr. Mercola:

Great strategy. I'm going to start recommending that for people who are doing fasting, longer and longer fast. It's crazy not to do it. I mean, the cost is so low and the benefits are so high, and there's virtually no harm or danger.

Tyler LeBaron:

Yeah. Well, and think about it, too. When you take hydrogen, you can increase gastric ghrelin secretion, and ghrelin is the hunger hormone. So, one of the first things you do when you fast is you increase ghrelin, and then ghrelin is extremely neuroprotective and anti-inflammatory and a whole bunch of benefits.

Tyler LeBaron:

Well, hydrogen also increases ghrelin. So, in a lot of ways, hydrogen mimics fasting. From autophagy to ghrelin, to a lot of other pathways that are activated, but it depends on the condition.

Dr. Mercola:

Yes, indeed. Wow! This is fascinating.

Tyler LeBaron:

You might consider with some of your fasting and things to actually eat, and then do the workout because if you're always doing at the tail end of your fasting, you can actually get more benefits by switching that up and actually have your food and then half an hour after that, do your hard exercise. By making-

Dr. Mercola:

So, what's the rationale for that? Help me understand.

Tyler LeBaron:

Because when you're exercising hard like that, you have – so, some of the studies, for example, how we're [inaudible 01:24:13] with taking your essential amino acids or your protein or different things before you work out, and the utilization of the amino acids and the proteins and everything, increased significantly higher by taking it before than by taking it after.

Tyler LeBaron:

By having higher substrate, so for example, on some other studies, when you're exercising, you have low glycogen levels because you've been fasting. Your central nervous system – a lot of things just tone down a little bit. Of course, you're more adapted, so it's not going to be as much, but there are still things that are going on to decrease total efficiency that you could possibly do.

Tyler LeBaron:

So, by having substrate energy and fuel and all this stuff in your body before you exercise, allows you to have a potentially harder, stronger, and better workout and utilize nutrients even more. Now, that's only going to work if you're doing this intermittent thing.

Dr. Mercola:

I imagine you say, yeah, that's the other component, once or twice a week, maybe.

Tyler LeBaron:

Yeah, or maybe some weeks on, some weeks off. I mean, I don't know what that option, that best thing is.

Dr. Mercola:

I'm going to try that because I do hard workouts with my personal trainer twice a week. So, that's a perfect opportunity to do that.

Tyler LeBaron:

Yeah, yeah.

Dr. Mercola:

Yeah, I love it. It's great. Whew! I wasn't expecting that benefit. If you provide some compelling evidence and at least stories to strongly support using this, it would seem from my perspective that it's almost medically negligent not to have molecular hydrogen in your cabinet, the tablets, just in case someone you know or love, maybe even yourself has a stroke or a heart attack. This should be one of the very first things that you're doing.

Dr. Mercola:

Let's go over some of the fine details of the dosing because, I mean, the normal dose is one tablet and that is high dose. If you put it in 500 mL, half a liter, which is about, what is that? 12 ounces, 16 ounces? 16 ounces, I think.

Tyler LeBaron:

16 ounces.

Dr. Mercola:

Yeah, 16 ounces. You're going to get about 9 to 10 mg/L, so that would be 4 to 5 mg that you'll be getting, but you can use more than one tablet. I mean, I take four, five, six tablets sometimes. I don't know what you're – you're probably taking 10 or 20 tablets at once. So, why don't you walk us through that and how you would put the tablets in the water?

Dr. Mercola:

I find that it's important to actually set a timer because you can't just put the tablet in the water and drink it. That's not going to work. You have to let it dissolve, and the rate at which it dissolves can vary from anywhere from one to two or three minutes, depending on how cold the temperature of the water. If you put it in iced water, it's going to take a long time. So, why don't you walk us through that and what do you think the tablet range should be?

Tyler LeBaron:

So, yeah, I've talked to the manufacturers.

Dr. Mercola:

Alex?

Tyler LeBaron:

Yeah, Alex.

Dr. Mercola:

Yeah. I've interviewed him before, too.

Tyler LeBaron:

Oh, yeah, yeah. That's right. I mean, he probably is better to talk about some of this stuff than I would, but at least from what I've seen and also when we've done some studies with the gas chromatography to get the highest concentration, it would appear that you probably want to use just your normal room temperature water, not cold water. Cold water, like you said, does take a long time, and then by the time it dissolves, most of the gas is already gone.

Dr. Mercola:

Yeah, and not sparkling water either, which you educated me on because sometimes on a flight, I like to use sparkling water, but not a good idea that it already has CO2 dissolved in it.

Tyler LeBaron:

Yeah, because sparking water can bring the gas out faster, yeah. So, yeah, maybe room temperature water, and then what we instructed some of the subjects to do, for example, is once you put the tablet in there, as soon as that tablet rises to the top of the water, that's when you start drinking it because by the time you finished drinking it, the tablet has fully dissolved. So, at that time, the water is very cloudy and milky and everything. That is the quasi suspended hydrogen gas in there, and you don't want to wait until it's clear because if you wait, then all the gas is just escaping into the atmosphere. So, you don't want that.

Dr. Mercola:

You won't get the benefit. You're just losing it.

Tyler LeBaron:

Yeah. Exactly. You're losing a very – I think if we did the test, I think you can measure close to 10 mg/L and then if you wait until the water was clear, you're only down to 2 mg/L, right?

Dr. Mercola:

That's 80% loss.

Tyler LeBaron:

Yeah, that's a pretty big loss. So, you're better off drinking the water prematurely than swallowing the last fifth of the tablet-type thing because it will just obviously react in the stomach acid. You don't get all the benefits, anyways. You're better off drinking it prematurely than you are waiting too long.

Dr. Mercola:

Any comments on the number of tablets? Any concerns of taking too many?

Tyler LeBaron:

Oh, just because it is magnesium, right? So, obviously, the DRI is what? Four hundred or 500 mg or so. Most other supplements are what? Two hundred to 300 mg of magnesium just for a supplement, and a lot of people, I think even you often will recommend maybe 1,000 or 2,000 mg of magnesium.

Dr. Mercola:

Yeah, especially if you're trying to mitigate against oxidative stress from EMF exposures because there's some strong suggestion in those definitive studies that I've seen published, but strong suggestions that

magnesium will serve as a calcium-channel blocker, where there's some compelling research that suggests that's part of the process that EMFs mitigate or mediate their damage cellularly.

Tyler LeBaron:

Yeah. So, I guess, if there's 80 mg, maybe don't take 10 every day.

Dr. Mercola:

All right. So, yeah, maybe four or five, but I think if you have a big exposure for whatever reason, like if you're flying at a high altitude or if you've gotten a heart attack or a stroke, I throw caution to the wind and maybe even those are the times where you maybe want to go to 10 and take a really high dose, but otherwise, just a few tablets would be useful.

Tyler LeBaron:

Yeah, and I agree with you. I do think that it's “prevention is better than cure” or, sorry, better than cure, yeah. I don't want to give any false hope. I'm excited about hydrogen and everything, but, honestly, we don't really know that if you take the tablet or hydrogen and then you have a stroke or something that you're going to be way better off and all of that stuff. We don't have the research for that yet, right? Maybe it will come. Maybe we'll discover five years from now that actually the biological effects are minimal.

Tyler LeBaron:

Because hydrogen gas is safe, then you need to make, as the consumer, the choice, "Okay. I have a possibility of, A, not benefiting me getting some good magnesium in the case of the tablet, or B, the possibility of actually getting good benefits." I guess I just want to say that I am very excited about the research is promising all this stuff, yes, but-

Dr. Mercola:

We don't have definitive clinical proven studies at this point, just strong suggestions, especially in animal studies.

Tyler LeBaron:

Yeah, yeah. I mean, it's exciting.

Dr. Mercola:

Harvard is doing the clinical trials now, so we'll know. So, that's good. So, any other studies that you've encountered or wanted to share or have we covered most of them?

Tyler LeBaron:

I think we've covered most of them. They'll be, I think, by the time we do our maybe next podcast or something, we'll have some more of that that we can share. There's always so much to talk about hydrogen because it really does cover so many different metabolic pathway and maybe there's a chance we can talk about a specific area or something like this where hydrogen could come involved or something. There's a lot we can talk about.

Dr. Mercola:

Well, this has been great. I want thank you so much for everything you're doing and you will do. Maybe next time we talk – you're going to get your Ph.D. pretty soon. Do you anticipate to have it this year?

Tyler LeBaron:

Yeah, yeah, I do. I mean, I don't know. It's a lot of work that we're involved with some publications and some research and things. So, one step at a time. Nothing is going to change. You always hope that at the end you're going to somehow learn something because you have a title or something.

Dr. Mercola:

Well, it's nice to give it a little validation. We knew you were the expert and really had the scientific mind and I so greatly appreciate your support when I'm writing my – my new strategy now is not to write books as I've shared previously and write scientific reviews. You're the main primary reviewer I sent to first for critical analysis because you never hesitate to tell me when I'm wrong or I've got this thing mixed up. So, I really greatly appreciate that about you.

Tyler LeBaron:

Oh, I appreciate that I'm given the opportunity and I really appreciate when I do give you maybe some criticism or something that you're always just so grateful for it. You're like, "Oh, man! I'm so glad you told me this." That's really good. I really appreciate that.

Dr. Mercola:

Yeah, yeah. It's a good collaboration. So, really appreciate everything you're doing, and we'll definitely have you on again maybe by the time you get your Ph.D. In the meantime, I would encourage those of you who are listening, there's been a lot of information shared here. It would be the rare individual who's not going to benefit from listening to this a second time. I'm going to listen to this a second time. So, really, I've gotten some really great insights on how to modify my current protocols. So, thank you so much, Tyler, and really appreciate it again.

Tyler LeBaron:

Yeah. Thank you, and you're welcome to look at my website, Molecular Hydrogen Institute. You're welcome to add me on social media.

Dr. Mercola:

Yeah. What's your social media handle?

Tyler LeBaron:

So, Facebook, just Tyler LeBaron. I just got an Instagram account recently. I post some stuff. When I'm out doing research sometimes, I'll post some new article, but it's TylerWLeBaron. You just look me up, and hopefully I can help spread the word.

Dr. Mercola:

Yeah. Well, that's what we're trying to do and you, too. So, all right. Well, thank you so much.

Tyler LeBaron:

Yeah. Thank you. Appreciate it.