Welcome to the Huberman Lab Podcast, where we discuss science and science-based tools for everyday life.
I'm Andrew Huberman, and I'm a professor of neurobiology and ophthalmology at Stanford School of Medicine.
Today we're discussing water.
To some of you, water might seem like a boring topic, but I assure you that water is anything but a boring topic.
In fact, water as a substance is incredibly interesting for a variety of reasons that I'll explain today.
First, we are going to discuss the physics and chemistry of water, and I promise to make it accessible to anyone and everyone, regardless of whether or not you have a physics or chemistry background.
And I will discuss how your body needs and utilizes water, depending on what type of water you drink, the temperature of that water, when you drink the water, and indeed how you drink that water.
Now, water is actually a pretty controversial topic.
In fact, in preparing for this episode, which took me several months, in fact, I ran into highly contradictory information and had to go on some real deep dives in order to ferret out the best and most accurate knowledge for you.
I also found that there are generally two camps of people out there in terms of how they think about water and the consumption of water.
One camp, generally speaking, is of the mind that tap water is completely safe.
Perhaps it needs a little bit of filtering, but that in most areas of the world, if it runs out of the tap, and unless there's a warning sign directly above the faucet, that you can drink the tap water.
The other camp seems to be the camp that does not trust anything that comes out of the tap and is excited by and, in fact, relies on things like reverse osmosis, deuterium depleted, hydrogen rich, or other forms of water that sometimes can be very expensive or at least involve some substantial steps in order to clean, filter, alter the chemistry of, or in some other way, adjust before they are willing to consume it.
So today, what we're going to try and do is to address all the stances around water.
For instance, we will discuss whether or not tap water is indeed safe, and I will give you some tools that will allow you to address whether or not the water coming out of your tap is safe, as well as some tools that will allow you to address how to clean that water if indeed it does need filtering and cleaning, in particular, for things like fluorides and endocrine disruptors, which it turns out are quite prominent in a lot, not all, but a lot of tap water sources.
I will also talk about the more, quote unquote, esoteric forms of water that I mentioned a few minutes ago.
So I will go systematically through the list of distilled, reverse osmosis, spring water, deuterium depleted water, high pH water, and for those of you that are already screaming out as you hear this, oh no, he's going to tell us that pH water can alter the pH of our body in helpful ways.
I'm not going to tell you that, but I will tell you that the alkalinity or acidity of

the water that is the pH of the water that you drink has a profound impact on your ability to absorb and utilize that water and the impact that those water molecules have on specific biological systems.
So it turns out pH is very important, but not for the reasons that you've probably heard about previously.
I will talk about how the temperature of water that you drink does indeed turn out to be important for the rate of absorption of that water and its impact on the cells, tissues, and organs of your body and thereby your health.
And I will talk about various zero cost and low cost tools that you can use in order to get the most out of the water that you drink.
And finally, I will talk about when and how to hydrate your body best.
Before we dive into today's topic, I want to share with you some very interesting results that were just published on the use of deliberate cold exposure to benefit fat loss.
Now, deliberate cold exposure is a topic I've covered before in this podcast.
We have an entire episode about that that I've linked in the show note captions.
Deliberate cold exposure can be done by way of cold showers or immersion in cold or ice water up to the neck.
That's typically the ways that it's done.
It has been shown to reduce inflammation, to increase metabolism.
And I think some of the most exciting results that have been published are the results certainly in humans showing that deliberate cold exposure can increase the release of so-called catecholamines,
which are dopamine, norepinephrine, and epinephrine.
And those increases in those three molecules are quite long lasting and lead to substantial increases in mood and focus throughout the day.
Now, many people out there hear about deliberate cold exposure and cringe.
Other people hear about it and cringe because they've heard that deliberate cold exposure, especially by way of immersion in water, can block the adaptation to strength or hypertrophy training.
What I mean by that is, yes, indeed, there are data showing that if one gets into very cold water up to the neck in the six hours, any time that is in the six hours after strength or hypertrophy training, that some of the strength and hypertrophy increases that one would observe
are blocked by that deliberate cold exposure.
However, after six hours does not seem to be a problem.
So it can be done on other days besides the strength and hypertrophy training.
It can be done before strength and hypertrophy training.
It can be done after endurance work.
And I should mention that it does not appear that cold showers disrupt the adaptations to strength and hypertrophy training, even if they are done immediately after strength or hypertrophy training.
Okay.
With that said, many people do enjoy the effects of deliberate cold exposure in particular for those increases in mood and alertness that are the consequence of those increases

in the catecholamines, dopamine, norepinephrine and epinephrine.
And again, those increases are very long lasting.
So it's not just during the exposure to cold.
It is for several hours, up to four, maybe even five or six hours, depending on how cold and how long the deliberate cold exposure happens to be.
Again, there's a lot to say and explore about deliberate cold exposure.
So again, I'll just refer you to the episode on deliberate cold exposure.
If you want to explore the mechanisms and the positive health outcomes, some of the controversies within the data, et cetera, within that episode.
Meanwhile, I definitely want to share with you the results of this recent study that just came out.
The title of this study is impact of cold exposure on life satisfaction and physical composition of soldiers.
The reason this study is very interesting is that it's one of the few studies that used, I should say, explored both deliberate cold exposure by immersion in cold water, as well as deliberate cold exposure by way of cold showers as it relates to weight loss.
Now there's already data out there on the effects of deliberate cold exposure and metabolism.
And here I'm mainly referring to the beautiful work of Dr. Susanna Soberg and colleagues in Scandinavia that showed that people that do 11 minutes total of deliberate cold exposure by immersion in cold water up to the neck per week.
So 11 minutes per week total, spread out across some different sessions by way of getting into water that's uncomfortably cold up to the neck and then getting out and then doing that several times per week to hit that 11 minutes or more threshold.
And this is very important.
We'll come up in a moment in the context of this new study and warming up not by getting into a warm shower, which is frankly what I do after my cold showers or getting into the ice bath or cold water immersion, but rather forcing their body to warm up naturally by using its own metabolic abilities.
In those studies, they observed substantial increases in brown fat stores, which are fat stores that you really want around the heart and clavicles, increases in metabolism that were quite dramatic in my opinion.
And that could be very beneficial for allowing people to feel more comfortable at cold temperatures when they're not in cold water and on and on.
So lots of benefits shown in that study.
In this study, what I thought was particularly interesting is again, they explored both immersion in cold water and cold showers and the duration of cold exposure that they found led to substantial fat loss, especially around the abdomen was very brief, deliberate cold exposure.
Let me give you a few details about this study.
The study involved 49 subjects that include both males and females.
This is also really important.
The beautiful work of Susanna Soberg and colleagues, as far as I know, only looked at males.
This study looked at males and females.
They were 19 to 30 years old and they're basically were two groups.
People either were assigned to get deliberate cold exposure or they were not assigned to

deliberate cold exposure.
The form of deliberate cold exposure involved one session per week of cold immersion in cold water up to the neck.
And to just give you a sense of how cold it was, it was three degrees Celsius, which translates to about 37 and a half degrees Fahrenheit.
That's pretty darn cold, but it was only for two minutes.
So one session at three degrees Celsius, otherwise known as 37.4 degrees Fahrenheit for two minutes
every week, once a week.
In addition, the same subjects did five cold showers per week or a minimum of five cold showers per week.
And those cold showers were slightly warmer than the immersion in cold water condition.
So they were 10 degrees Celsius approximately or 50 degrees Fahrenheit, still pretty cold.
And the duration of that cold water exposure in the shower was just for 30 seconds.
So this is interesting to me because many people don't have access to cold water immersion.
They might not have an ice bath or any place they can do that, but most people do have access to a cold shower of some sort.
Plus, I think most people could do probably one ice bath per week or find a place where they could get into cold water safely.
Now I should point out that some people will not do well going into 37.5 degree Fahrenheit, aka three degrees Celsius water, having never done anything like this before.
So if you're going to try and employ these sorts of protocols that were used in the study, I do recommend that you ease into it over the course of a week or so and become somewhat adapted to the shock of cold water exposure.
So maybe start at, you know, 50 degrees Fahrenheit, kind of ease your way back in terms of the cold water immersion especially.
Now another critical feature of this study is as with the beautiful work by Susanna Soberg, the subjects were told to warm up naturally after the deliberate cold exposure.
So they basically hung out outside of the cold water immersion or outside of the cold shower for 10 minutes after they were exposed to the cold in their bathing suit or I'm assuming they were wearing something.
But the point is that you are not going from deliberate cold exposure directly into a hot shower or a sauna or something of that sort.
So again, their bodies were forced to heat up again naturally after the deliberate cold exposure, but after the 10 minute period, they were able to do whatever they wanted essentially recloth, take a warm shower and so on and go about their day.
Now the results of this deliberate cold exposure protocol again, two minutes in cold immersion at three degrees Celsius, 37.5 degrees Fahrenheit plus five cold showers per week of two minutes long, a little bit warmer, 10 degrees Celsius, 50 degrees Fahrenheit.
Now the deliberate cold exposure used in this study caused many different statistically significant positive changes.
They had a very extensive questionnaire that related to mood, everything from levels of anxiety to sexual satisfaction and on and on.
In fact, they saw a statistically significant improvement in sexual satisfaction in the

subjects that were exposed to deliberate cold exposure, not in the control group.
Although they didn't look at this, chances are those improvements in sexual satisfaction were the downstream consequence of the known increases in testosterone and free testosterone that occur in both men and women who do this sorts of deliberate cold exposure.
Again, testosterone being important hormone for libido in both men and women.
They also saw improvements in regulation of anxiety, which I think is very interesting given that the deliberate cold exposure often causes people anxiety.
But here and in other studies, we've seen it can lead to and a better ability to buffer against anxiety in the normal happenings of everyday life.
Perhaps the most interesting and significant results that they found in the study, however, were that in particular in men, there was a reduction in waist circumference following eight weeks of this deliberate cold exposure, as well as a 5.5% on average 5.5% reduction in abdominal fat that was quite statistically significant when compared to the other groups.
Now why there was no observed reduction in abdominal fat or waist circumference in the female subjects isn't clear, could have to do with just the way that body fat is stored and metabolized in females versus males.
That is going to be a topic for future exploration.
So I do think the study is very interesting because when you look at the landscape of science and discussion around deliberate cold exposure, I think there's a general consensus now that deliberate cold exposure can change one sense of mood and well-being through the increases in catecholamines that I mentioned earlier.
But the impact on metabolism itself has been somewhat controversial because the overall changes in metabolism that are observed while statistically significant in many studies have not ever really been shown to translate into weight loss or body fat loss in any kind of specific way.
And of course a great advantage of this study is that by exploring soldiers, they were able to really hold constant a number of other features like the amount of daily activity that those soldiers are exposed to, their diet, their living conditions and so on and so forth.
So at least insofar as human studies are done, it's a very well controlled study.
We'll provide a link to the study in the show note captions.
And for those of you that are thinking about employing the protocol that's used in this particular paper or combining it with existing deliberate cold exposure protocols, to me it seems pretty straightforward and of pretty minimal time investment.
Just two minutes of deliberate cold exposure by way of water immersion up to the neck and five times a week of 30 seconds each of deliberate cold exposure by way of cold shower.
And just a quick mention about cold showers, if you're going to use cold showers to do deliberate cold exposure, you're going to want to stand under the shower itself, right?
And essentially have it hit your head, the back of your neck and your upper back, which is where most of your brown fat stores are concentrated.
It turns out that cold exposure to those regions of the body in particular are going to trigger the adaptation of increased brown fat stores, which involves increases in mitochondria in those fat.
Again, this is not the blubbery fat beneath the skin.

This is the fat that acts as kind of an oil in the furnace that is your thermogenic properties of your body to generate heat and burn off so-called white adipose tissue elsewhere in the body.
Now, anyone that understands the laws of physics and thermodynamics will be saying, wait, in order to get fat loss, you need to have a caloric deficit.
Calories in, calories out still applies.
And yes, that's absolutely true.
We can only conclude on the basis of the results of this study that the people that lost body fat were indeed in a caloric deficit, presumably because all other factors were held more or less constant in this group of soldiers, presumably because the deliberate cold exposure itself elevated metabolism, thereby increasing the calories out component of the calories in calories out equation, which of course governs the rules of weight loss and body fat loss as well.
Before we begin, I'd like to emphasize this podcast is separate from my teaching and research roles at Stanford.
It is, however, part of my desire and effort to bring zero cost to consumer information about science and science related tools to the general public.
In keeping with that theme, I'd like to thank the sponsors of today's podcast.
Our first sponsor is Element.
Element is an electrolyte drink with everything you need and nothing you don't.
That means plenty of salt, magnesium and potassium, the so-called electrolytes, and no sugar.
Now, salt, magnesium and potassium are critical to the function of all the cells in your body, in particular to the function of your nerve cells, also called neurons.
In fact, in order for your neurons to function properly, all three electrolytes need to be present in the proper ratios.
And we now know that even slight reductions in electrolyte concentrations or dehydration of the body can lead to deficits in cognitive and physical performance.
Element contains a science-backed electrolyte ratio of 1000 milligrams, that's one gram of sodium, 200 milligrams of potassium and 60 milligrams of magnesium.
I typically drink Element first thing in the morning when I wake up in order to hydrate my body and make sure I have enough electrolytes.
And while I do any kind of physical training and after physical training as well, especially if I've been sweating a lot, if you'd like to try Element, you can go to DrinkElement, that's lmnt.com slash Huberman to claim a free Element sample pack with your purchase.
Again, that's DrinkElement lmnt.com slash Huberman.
Today's episode is also brought to us by Thesis.
Thesis makes custom Neutropics.
Now, Neutropics is a word that I don't like.
I don't like it because it means smart drugs and as a neuroscientist, we know that we have brain circuits for focus, brain circuits that enable creativity, brain circuits that allow task switching and on and on.
So there's really no such thing as a brain circuit for being smart.
Thesis understands this and has designed custom Neutropics that are designed to get your brain and body into the optimal state for the specific types of work that is physical or cognitive

work that you want to do.
I've been using Thesis for more than a year now and it's completely changed the way that I approach work.
I typically take the clarity formula prior to doing any kind of cognitive work and I'll take their energy formula often before workouts.
If you'd like to try your own personalized Neutropic starter kit, you can go online to takethesis.com slash Huberman and take their brief three-minute quiz.
That quiz will allow them to send you four different trial formulas that you can use for a month and then you can iterate with them to find the ideal Neutropic formulas for you.
So takethesis.com slash Huberman and use the code Huberman at checkout to get 10% off your first order.
Today's episode is also brought to us by HVMN ketone IQ.
Ketone IQ is a ketone supplement that increases blood ketones.
Many people have heard of the ketogenic diet and indeed the ketogenic diet has been useful for many people out there.
However, most people out there, including myself, do not follow a ketogenic diet.
That is, I eat carbohydrates.
However, it's important to note that even if you are not on a ketogenic diet, you can benefit from increasing your blood ketones.
In fact, I'll use ketone IQ after lunch or in the afternoon with some coffee or sometimes first thing in the morning.
If I'm particularly hungry and I want to do exercise or I want to do cognitive work, but I want to delay my first meal, using ketone IQ allows me to curb my hunger and gives me a lot of focus and energy.
And that's because ketones are one of the brain's preferred fuels for cognitive work.
In fact, ketones have been shown to be associated with forebrain function, which is associated with context switching, focus and formulations of strategies, et cetera, all the sorts of things that are important for doing deliberate focus work or physical performance.
If you'd like to try ketone IQ, you can go to hvmn.com slash Huberman to save 20% off your order.
Again, that's hvmn.com slash Huberman.
The Huberman Lab Podcast is now partnered with Momentus Supplements.
To find the supplements we discussed on the Huberman Lab Podcast, you can go to livemomentus spelled O-U-S livemomentus.com slash Huberman and I should just mention that the library of those supplements is constantly expanding.
Again that's livemomentus.com slash Huberman.
Let's talk about water and let's start off by answering the question, what is water?
Water is of course H2O, most everybody knows that from an early age, but what H2O means is that each molecule of water consists of two hydrogens and one oxygen.
The physical arrangement of those two hydrogens and one oxygen turns out to be really important for how water functions in the body and frankly elsewhere in our world and life.
If you were to make a peace symbol, that is to put up your index finger and your middle finger simultaneously.

In fact, I'm going to recommend you do that now, unless you're using your hands for something else important, in which case do it later.
If you make that peace symbol and you look at your hand, you have a pretty good impression of what an individual water molecule consists of, which is H2O, two hydrogens and an oxygen.
With that peace symbol, the fingers or the tips of your fingers rather are going to represent the hydrogens.
Your fingers, that is the length of each of those fingers is going to represent the electron bonds to the oxygen and the palm of your hand and the fingers that are down are going to represent the oxygen.
What's important about that visual impression or visual image of the individual water molecule is that it is polarized.
That is the hydrogens over on one side, both of them are over on one side and the oxygen is over on another.
What's really important about water molecules being polarized is that they can bind to one another by way of that polarization and this has to do with something that we all kind of learned in chemistry at one point, but many of us forgot, maybe we didn't even understand it the first time around, which is that positives and negatives attract.
When you have individual water molecules, they have the opportunity to interact and essentially bind to one another and they bind through what are called covalent bonds.
Covalent bonds are relatively weak bonds and so as a consequence, water can change its confirmation.
However, covalent bonds are strong enough that water actually can maintain some structure and that structure will vary, of course, depending on its temperature.
What you need to know about water is that indeed it consists of lots of individual H2Os and those H2Os can arrange themselves in different ways and that temperature is a strong determinant of the arrangement of those water molecules.
That is, they're bonding to one another and in fact, even their spacing between those bonds.
Again, even if you don't have any chemistry, stay with me because you'll definitely understand this.
Water can exist in at least three forms and maybe four forms.
We know that it can be liquid, of course, that's really normally what we think of when we think of water.
It can be gas, so we think of steam, so if you heat it up, it takes on a, not a semi-solid or a semi-liquid form, it takes on this property of steam or gas.
When you see steam or when you breathe on a cold day through your mouth or through your nose and you see your air, those are water molecules that are condensing that is bonding in certain ways based on differences in temperature between the inside of your body and the outside air.
Of course, it can be a solid, it can be ice.
Ice is fascinating and important in understanding how water works and this will become relevant later when we think about how water works within the body as well, especially how different temperatures of water impact the health and behavior of ourselves.

The most important point to understand about water in its solid state is that unlike most substances, when water is in its solid state, it is actually less dense than when it's in its liquid state.
So just think about that.
Most substances, most metals, for instance, when they are in a solid state, they are more dense than when they are in a liquid state.
So for instance, if they're in a solid state, they will sink in a container filled with their liquid form, not water.
Water is very interesting because as you cool water and water transitions from a liquid to a solid, it still binds.
That is, it could form bonds between those different molecules of water, but the spacing between those H2O, so again, those peace symbols with hands, so if you had a bunch of those, if you had a thousand hands, all making peace symbols, they can bond to one another.
But when it's cold, those bonds are actually made further apart from one another.
And as a consequence, ice, as we all know, floats in water.
In other words, put very simply, water is unusual and special in that in its solid form ice, it is actually less dense than when it's in its liquid form, and that's why ice floats in water.
Now, this is important not just to our biology, but to all of life, because if you think about it, if it were not the case that water is less dense in its solid form ice than it is in its liquid form, the bottoms of our oceans would be covered with thick sheets of ice.
And if that were the case, you can be absolutely sure that life would not exist on our planet the way that it does.
And there's a good chance that we would not exist as a species because so much of what allows us to exist on this planet and the other animals to exist on this planet relies on photosynthesis pathways and plants that are dependent on the sun and interactions with the oceans and lakes and other bodies of water.
And of course, the ice caps are vitally important.
That is the presence of ice, especially at the poles, but elsewhere in bodies of water as well.
So icebergs are a critical part of the ecosystem that allows for everything from photosynthesis to the ability of certain animals to extract food from each other and from their local resources.
Now, there's a whole discussion to be had there, but the important point for now is that the physical properties of the bonds between water that are made and changed, depending on temperature, turn out to be essential for us to be present on this planet at all and for our cells to function in the ways that they do for sake of health and for sake of disease.
And we'll explore this later when we talk about the critical relationship between temperature, pH, which is the relationship between alkalinity, how basic or acidity, how acid, a given liquid, or in this case, we're going to be talking about water is, and the ways that our cells can or can't use water.
So I realize that this is fairly in-depth for those of you that don't have much of a background in chemistry.

I've tried to keep it really top contour.
But if you can make a piece symbol or if you can just imagine a piece symbol in your mind and realize that that's a water molecule and that those water molecules combined to one another through bonds that are relatively strong, but weak enough that they can be broken if they need to and that the temperature that those water molecules are exposed to changes the distance between those bonds.
And that's what allows ice to float in water.
Then you are going to have no problem with the remainder of the discussion today.
In fact, you will also have the ability to understand things that you've observed many times over, but perhaps I've never thought about or really understood, which are, for instance, that water has a certain level of surface tension.
For instance, if you've ever been to the ocean and the waves are coming in, what you'll notice is if you walk on the dry sand or gravel of pebbles, that is, of the ocean, it's very easy, right?
I mean, the pebbles move down or the sand moves down.
It depresses a little bit due to the weight of your body.
But as you get closer to the water, you're going to sink deeper because that sand is more saturated with water.
But at some point, you won't be able to actually walk on top of the water, right?
It has been said that Jesus walked on water.
There's the so-called Jesus Christ lizard, so named because it can actually walk on the surface of water, a leaf can float on the surface of water.
Under some conditions, a coin can float on the surface of water.
If you make coffee in the morning, you can actually take a spoonful of that hot coffee and pour a little bit on the surface of your coffee and you'll notice that it will bead up and you'll get little round spheres of water.
Those are little water molecules bound to one another that spin on top of the surface before they sink under.
That has everything to do with the bonding between water that's dependent on temperature, but also as with the difficulty for essentially everybody to walk on water or for animals to walk on water.
The surface tension of water allows certain things to float there or to stay at the surface, but there's a very thin layer of water molecules at the surface of water that are more dense than the water that resides at deeper depths.
And that's why most things, including us, sink in water.
We are more dense than water.
Now I did mention earlier that there are three forms of water.
Those are the ones that we all are familiar with, the solid, liquid and gas forms of water.
However, there are data mainly from Gerald Pollock's laboratory at the University of Washington that have described the so-called fourth phase of water, which is structured water.
And we'll get into this a little bit later because structured water has really been a prominent topic in the, let's call it the water health aficionados.
It's a heavily debated topic as to whether or not structured water is somehow better for

ourselves, if it exists within our bodies, we'll get into that in full detail later.
But the whole notion of structured water is that in the presence of certain solids or certain liquids, the confirmation of water, that is the water molecules, actually change somewhat.
This has been demonstrated whether or not it has relevance to the biological function of our body is a different issue.
But we know that there is this fourth phase of water called structured water.
Structured water is a fairly complicated topic, but we can make it very simple for sake of today's discussion.
I mentioned earlier that opposite poles attract, that is positives and negatives attract and typically things that are negatively charged when presented with another negative charge, either repel or don't attract things that are positively charged in the presence of another positive charge also tend to repel.
This is the basis of magnets either sticking to one another or repelling from one another.
There's also the idea that human beings who are opposites attract, but that's a different episode that we need to do in the future.
The point here is that structured water is a unique condition in which the local environment that these water molecules happen to be in allows positive charges between different water molecules to attract one another.
So again, whereas normally it's positive and negatives that attract in the configuration that we call structured water, positives and positives attract and form bonds that are stronger than the typical bonds that would be formed between water molecules.
And just as it kind of prelude to our discussion about structured water as it may or may not relate to health later, there are a number of people that believe that within the body, because of the presence of certain liquids and solids, that the water within our cells and in particular within the interactions with so-called organelles, organelles are things like mitochondria, the Golgi apparatus, they have fancy names.
These are the things within cells that allow cells to do everything from make proteins to traffic proteins out to the surface of cells, things like neurotransmitters and receptors and so on.
A lot of people who are interested in structured water as it relates to biological function have hypothesized or like to debate rather whether or not in the body, water is not just present in its liquid form or gaseous form.
We know it's not present in its solid form unless you gulp down some ice cubes, for instance.
But there is a cohort of people out there, including some fairly accomplished scientists that believe that within the body, the organelles of our cells act as a substrate for water to exist in this fourth form, this structured water form.
And that's led to this whole niche industry of people who are proponents of consuming so-called structured water.
And again, we'll get to that a little bit later.
So now you know what individual water molecules consist of when you hear H2O, hopefully you'll get that visual image in your mind of an individual water molecule being the peace symbol and a bunch of those binding to one another through these relatively weak bonds, but strong enough that certain things can take place like surface tension.

Keep in mind that surface tension of water may relate to either standard bonds between water or this fourth phase.
That's heavily debated still.
But we certainly know that, for instance, if you were to take a piece of wax paper or glass and you were to pour some water on it, you would notice that the water would bead up or kind of aggregate at particular locations.
When you see that beading up or the aggregation of water molecules on a particular surface, you're seeing two things.
This is actually kind of fun.
The next time you see it, you'll know that the aggregation, the beading up of water with itself.
There are individual water molecules or many water molecules kind of aggregating at one location and making a bead of water.
That's due to these bonds, these covalent bonds occurring between water molecules.
But also you'll notice that on a vertical pane of glass, say in rain or on your windshield, that the water will look almost like it's sticking to the glass.
And that's because there are actually bonds between the water molecules that have beaded up themselves and the glass.
So water can not just bind to itself, it can also bind to certain surfaces.
And the fact that perhaps if you drive your car, if you were to tap the window or if a big enough bead of water formed on a window that it would start to drip down, and that's because those bonds with the surface are strong, but they're not so strong that it stick at that location.
Quite different than water that is in its solid form, ice, that can actually really adhere.
If you've ever had to scrape ice off a windshield, so for those of you who live in cold regions, you're familiar with this.
If you scrape ice off a windshield, you realize that the bonds between water in its solid form and different surfaces is quite a bit stronger than the bonds between different water molecules with each other or the bonds between water and different surfaces when they are warmer.
So I do realize that for a lot of people listening, that's going to be a pretty deep dive into the chemistry and physical properties of water.
But all you really need to know is that these water molecules are incredibly versatile and they can bind to each other and can bind to different surfaces and can allow things to float or to sink or even to move across surfaces of water based on the three, perhaps four different states that water can be in.
And that versatility that you observe in the natural world on window panes and rain and clouds and hail and ice and snow and scraping ice off your windshield in the cold of winter and perspiration and so on, all of that is fine and good, but realize that almost all of those same sorts of properties of water become extremely relevant when thinking about how your body actually utilizes water.
And the key thing here is that temperature and the so-called alkalinity or acidity that is the pH of water turn out to be very important determinants of how water is used by the cells of your body.
In fact, as I'll describe in a moment, we have entire sets of biological mechanisms

solely devoted to trying to get water into our cells in very specific ways, including at specific rates and to use water in different ways, because as you've probably heard before, we are mostly water.
What's kind of interesting to me and what I found researching this episode is that the percentages of our cells and bodies that are purported to be water is a pretty broad range.
Some people say we're 55% water, other people say we're 70% water, some people say we're 95% water.
The exact percentage doesn't matter so much and really just boils down to whether or not the person that's stating that percentage is talking about how much water is present in our cells and body at a given moment versus how much water was involved in the process of creating the sorts of proteins and other things of our body that are required to have hair, cell, skin cells, brain cells, et cetera.
So if you really want a number out there, I can't give you a single number.
If you want to be accurate, it's going to have to be a range.
And basically we are anywhere from 70% to 90% water, depending on how you define being water.
That is whether or not you're talking about water being present in cells in its liquid form or maybe in this fourth structure water form if you're of the mind that that exists within us and whether or not you're talking about water that was used to create a given protein like a receptor or a neurotransmitter or whether or not you're talking about the water just being water as H2O.
So again, it's very easy to go down that rabbit hole and this is part of the reason why there's such a wide discrepancy of assertions as to how much of us is water.
But let's be direct.
Most of our body is water and there isn't a single other molecule in the universe that we can look to and say that it has as important a role in our health and biology and frankly our presence of life on earth at all, then water.
I'd like to take a quick break and acknowledge one of our sponsors, Athletic Greens.
Athletic Greens now called AG1 is a vitamin mineral probiotic drink that covers all of your foundational nutritional needs.
I've been taking Athletic Greens since 2012, so I'm delighted that they're sponsoring the podcast.
The reason I started taking Athletic Greens and the reason I still take Athletic Greens once or usually twice a day is that it gets to be the probiotics that I need for gut health.
Our gut is very important.
It's populated by gut microbiota that communicate with the brain, the immune system and basically all the biological systems of our body to strongly impact our immediate and long-term health and those probiotics in Athletic Greens are optimal and vital for microbiotic health.
In addition, Athletic Greens contains a number of adaptogens, vitamins and minerals that make sure that all of my foundational nutritional needs are met and it tastes great.
If you'd like to try Athletic Greens, you can go to athleticgreens.com slash huberman and they'll give you five free travel packs that make it really easy to mix up Athletic Greens while you're on the road in the car on the plane, et cetera, and they'll give you a year supply of vitamin D3K2.

Again, that's athleticgreens.com slash huberman to get the five free travel packs and the year supply of vitamin D3K2.
Okay, so now at a minimum, everyone out there should understand that water has a particular structure.
So when you hear H2O, you can kind of imagine that structure and that the water molecules can change their conformation.
That is they can bind to other water molecules and it turns out they can bind to other things and actually change the conformation of other things.
A good example of that is something we're all familiar with, which is water's ability to dissolve certain substances like sugar or salt.
And that is because salt molecules or sugar molecules are what we call hydrophilic.
They like water.
And when we say they like water, it just means that the chemical structure of salt, sodium or the chemical structure of say sucrose like table sugar can actually interact with the hydrogens and oxygens of water and can change those salt molecules or sugar molecules, turning them from solid into liquid, essentially creating what are called solutes, which is basically the dissolving of solids into a liquid solutions.
In fact, water is one of the best solvents on the planet.
In fact, water is better at dissolving many solids than is acid.
That's how incredible water is and there are a number of reasons related to the chemistry of water that can explain that.
But as we transition from talking about the physics and chemistry of water to how water actually behaves within our body and contributes to our health or to disease, depending on the case, it's important to understand that molecules such as sugar and salt can be hydrophilic or as we know, oil and water don't mix.
That's because oils, lipids are so-called hydrophobic.
What's hydrophobic?
We'll just think phobic.
Certain molecules such as lipids don't dissolve well in water and we all intuitively understand that.
If you take some olive oil, for instance, and you put it into a little glass of water, it'll likely float or beat up or form a little spherical or amoeba like shapes within the water.
And that's because oil, lipids are hydrophobic.
So different substances out there are either going to be more hydrophilic.
That is, they are going to have a greater propensity to interact with water and bind with the different aspects of the water molecules or hydrophobic to have less of a propensity to interact with and bind with water molecules.
And I've been alluding to this numerous times throughout this podcast already, the temperature of water and the pH, that is the alkalinity or acidity of water will have a strong impact on whether or not a hydrophilic or hydrophobic substance will have a greater or lesser tendency to interact with water.
You all know this intuitively as well.
If you've ever tried to dissolve say a big tablespoon of sugar in very cold water, you'll

notice that the grains don't dissolve as quickly as when you take that big tablespoon of sugar and put it into a warm or hot cup of water.
And that's because the temperature of water actually changes how well that sugar molecule is able to change its confirmation and interact with the water molecules.
Likewise, if you want to get something that's really hydrophilic into an aqueous, that is a water containing solution, the temperature is also going to strongly impact that.
Now there are a near infinite number of examples of how temperature and pH impact the tendency of hydrophilic and hydrophobic substances to dissolve in water or not.
We're not going to go into all those details.
But as we migrate from our discussion about the physics and chemistry of water into how water behaves within our body, which is what we're going to do now.
And then as we continue into the third part of our discussion, which is why and how certain types of water that some of you are familiar with like different pH water, distilled water, reverse osmosis water, why those different types of water are thought to and in some cases do in fact change the ways that our cells function for better or for worse.
All of that will come together and make sense for you.
Okay, so all the cells of your body, every cell, even your bones, that is the osteoblasts and the other cells within your bones, your bone marrow, your red blood cells, your white blood cells, your neurons, your nerve cells, your liver cells, your kidney cells, all of them require water.
In order to get the proper amount of water into those cells, there are basically two ways that water can access those cells.
Now, if we zoom out for a second and ask ourselves, how does water actually get into the body?
Most of us just think, oh, we drink that water into our body.
Of course, that's the main way.
We can also breathe water molecules into our body through humid air.
When you hydrate your cells, that is, when you're bringing water into your cells, that water needs to move from your gut and into the bloodstream and eventually into the individual cells, whatever cell type that may be.
And there are basically two ways that water can access those cells.
The first way has been known about for a very long time and that is so-called diffusion.
Now the outside of most cells is made up of fatty stuff, lipid.
So for instance, neurons, nerve cells have a lipid bilayer.
It's two layers of fat.
And you already know that fat, lipid, is very hydrophobic, okay?
Now that turns out to be not a problem, but a solution for how water can get across that lipid barrier.
Why?
It is the fact that water can change its confirmation and lipids can change their confirmation just enough so that the bonds between water and the bonds between those hydrophobic lipids can interact, allowing the water molecule to basically pass through the lipid because it can bond very weakly or in some cases not at all, but very weakly to those lipids.
And then be pushed through to the other side.
Really incredible if you think about it.

If there was too much of a hydrophobic relationship between the lipid and the water, the water would come up to the surface of that fatty outside of our cells and then would be repelled away from it or would just stay there right at the surface.
And that would be no good because we actually need that water to diffuse across the cell membranes where actually it's a double cell membrane, as I mentioned before, two layers.
So water and lipids of cells can interact with just enough affinity that the water molecule can diffuse across those cell membrane barriers.
But, and this is an important but, the diffusion of water molecules across those lipid barriers on the outsides of cells is a fairly slow process compared to the other way that water accesses cells.
And this other way that water accesses cells is really something that was just discovered about 10 years ago.
So this is a fairly recent discovery, which has to be a fundamental discovery, which is the presence of what are called aquaporin channels.
Aquaporin channels are basically portals through the membrane that allow water molecules to move very quickly across cell membranes at a rate of about one million H2O's, one million water molecules per second.
And the way that water molecules move across the cell membrane through those aquaporin channels is very interesting.
The inside of those channels and the way to think of these is they're literally tubes stuck through the membranes of cells.
The insides of those channels are very hydrophobic, allowing those water molecules to just jut really quickly, almost as if in your mind, you can just imagine as if it was lubricated for the water.
Although it's not really lubricated.
The water molecules can move through in single file, a million per second.
Now, why would you need two ways for water to get across cell membranes?
One fairly slow through basic diffusion.
And again, diffusion folks is the movement of things from a gradient of higher concentration to lower concentration, which just think about this as things tend to run downhill from higher concentration to lower concentration.
They try and create equilibrium across space.
So if you had a bunch of marbles on one side of a box, just imagine that these were water molecules because of the charges between those hydrogens and oxygens, there's a tendency for those marbles to spread out and essentially take on a fairly even confirmation.
That's basically just diffusion across a space.
Water molecules will also move from higher concentration to lower concentration across cell membranes.
And then you have these portals, these tubes or these channels as they're called, these aquaporin channels where water molecules can move very quickly.
Now, the reason why biology seems to have created these aquaporin channels, and again, I wasn't consult with the design phase, but the most logical explanation is that we have many tissues within our body that often need water very quickly or need to release water very quickly.

Let's think about a couple of these and then let's look at what the actual distribution of aquaporin channels is throughout the body.
What is an area of your body that on occasion will need to move water very quickly out of it?
You can use your imagination here, but I'll just tell you that, for instance, your tear glands or tear ducts need to release tears very quickly.
So you need to take water that's stored in your body if there's an emotional experience or if you look at a very bright light, for instance, or God forbid, if you get some sort of irritant in your eye, you're going to start to tear up.
And those tears are the release of fluid from those tear ducts.
And so it's going to be the very rapid release of water from those tear ducts through so-called aquaporin channels.
And in fact, aquaporin channels are heavily expressed.
There are many of them in the cells of the so-called lacrimal glands that release tears.
In addition, we need to absorb water from the gut.
And the gut has a lining and ethereal lining and other cell lining, mucosal lining and water needs often to move very quickly from our stomach into the rest of the body.
And one way that is accomplished is through aquaporin channels that are expressed all along your gut.
So the discovery of these aquaporin channels is really highly significant in terms of understanding the different ways that water can interact with and get into the cells of your body.
There are aquaporin channels, not just in the lacrimal glands that allow for tearing or within the gut, but in many tissues within your body in there, you even have different distributions within those tissues.
In fact, as one looks at the expression of the different aquaporin channels because it turns out there are different forms of them across all the cells and tissues of the body, there's really no single tissue within the body except perhaps the bones of your body and perhaps the ligaments to some extent that don't have these aquaporin channels.
Some of you out there may have heard of the so-called fascia, fascia and sheath muscles, a unique kind of connective tissue that gives some pliability and yet some rigidity that allow for a lot of the physical abilities of your musculoskeletal system.
It's incredible tissue.
We'll do an entire episode about fascia at some point, fascinating, fascinating tissue.
Fascia even contain aquaporin channels.
So the role of aquaporin channels in fascia probably relates to our specific needs to be able to use specific muscle groups in particular ways at particular times.
In other words, if you're sleeping or lying down or sitting, you're not using your musculoskeletal system as much as if you're running or performing some repetitive behavior, it turns out that the aquaporin channels in certain tissues like the fascia can be used when we transition from low mobility states to high mobility states, allowing more perfusion or access of water into particular cells of the body when we need it.
So it's just fascinating, fascinating channels, these aquaporin channels.
Again, only discovered fairly recently, so we're still learning new things about our biology all the time.

Now a very important feature of the aquaporin channel is that the movement of water molecules across the cell membrane through those aquaporin channels is strongly dependent on the temperature
of water and the pH of water.
This becomes especially important in our description and our deep dive into so-called alkaline water or higher pH water a little bit later.
But I'll just give you a little teaser for now because I'm sure that a number of people are wondering about this.
If you go into the store or even a convenience store, you will see pH water.
Now every water has a pH, right?
Lower numbers mean more acidic, higher numbers mean more alkaline or more basic.
You'll see pH water, that is 7.4, you'll see 7.8, you'll see 9.8, you'll see a huge range of these things and there are many, many different claims about how the pH of water is important for regulating the pH of the body.
Here's the real story.
The pH of your body, that is the pH of the cells at different locations in your body is strongly, strongly homeostatically regulated.
What do I mean by that?
It means it doesn't change that much, which means that you have very specific biological mechanisms that ensure the pH is maintained, for instance, in the skin cells of your skin, in the retinal cells of your eye, in your brain cells.
Now it is true that across the body, different cells and tissues have fairly widely varying pH.
Now it has been said that the pH of bodily tissues is generally between 7.2 and 7.4.
However, if you were to look at the pH of your gut and keep in mind that your gut is not just your stomach, your gut is the entire pathway ranging from your throat all the way down to where you excrete things out of your body.
That entire pathway has different pH levels depending on where you are along the gut and intestinal pathway.
And in fact, having much lower, that is more acidic pH at certain locations along your gut pathway is what allows those gut microbiota, those little microorganisms of which you have trillions and that are important for regulating everything from neurotransmitter production to hormone production that allow them to flourish and do well.
That said, except under conditions of hemorrhage or changes in blood volume that are of a dangerous
level that can lead to seizure or even death, the pH of the rest of the cells of your body and also those gut cells doesn't change that much on a moment to moment basis.
So if somebody tells you that you should drink alkaline water or alkalized water as it's sometimes called in order to keep your body more alkaline and less acidic, there is essentially no basis for that at a macroscopic level or even at a local level.
Now, what that does not mean is that the pH of the water that you drink is not important.
In fact, if the pH of the water that you drink is too low, that is, if the water that you consume is too acidic, it will not move as quickly from your gut into the other regions of your body and therefore the other cells of your body that require that water will

not be able to access it as readily.
You've probably experienced this if you've consumed certain water and it feels like it's sloshing around in your stomach or it feels like it's just somehow staying there or you feel it, it's presence more, not just as volume, but it's almost as if you can feel the little waves of water along the inside of your gut.
Now, sometimes that can relate to temperature, but oftentimes that can relate to the pH of that water.
And it turns out it is true that water that is more alkaline, that is, pH of 7.4 or higher can move more readily across the aquaporin channel.
And in terms of absorption of water from the endothelial lining and the other cell type lining of your gut into the rest of your body, it is true that higher pH water provided that pH isn't too high is going to be absorbed more quickly, which partially explains why some people have an affinity for this higher pH water.
Now this is not to say that you need to consume high pH water in order to hydrate your body properly.
I want to be very clear about that.
However, if you are interested in what the value of elevated pH water is, it largely has to do with this accelerated absorption.
And as we'll talk about a little bit later, there is also growing evidence that it can adjust the function of certain cells that are within your immune system and thereby reduce certain inflammatory responses.
So I realize as I'm saying this, some people out there are probably thinking, Oh no, this guy is like a pH water proponent.
He's saying we have to drink alkaline water or buy very fancy water.
Now I want to be clear that is not what I'm saying.
And I'm also not saying that you need to purchase very expensive water in order to derive the maximum benefits from the water that you drink.
It turns out there are a few things that you can do by way of temperature and by way of filtering water and a few other tricks that I'll tell you a little bit later that will allow you to increase the absorption rate of water in the gut, which turns out to be a very interesting but also potentially important thing to do for not just reducing inflammation, but also making sure that you're getting proper hydration of different cell types in your body, including rapid hydration of your brain cells, which as we'll also talk about in a few moments can greatly enhance cognitive function.
Okay, so we've talked about how water can get into cells.
There are two ways diffusion and movement through these aquaporin channels.
We've earmarked the discussion that the temperature and the pH of water, that is the confirmation of water.
And here I really want to embed this in people's minds that when we talk about temperature of water and pH of water, we're really talking about the arrangement of those H2O's, those water molecules.
So keep that in mind.
We've covered how water can get into cells through those two different ways diffusion and through the aquaporin channels.

What we haven't talked about is what happens to water once it's in cells.
And this is very simple to explain.
Once water is inside of cells, it's going to be incorporated into the different proteins and organelles.
Again, organelles are things like mitochondria, the nucleus of the cells, which is contained to the DNA and so forth, in different ways, depending on which proteins are there and how hydrophilic or hydrophobic those proteins are, or in some case, aren't.
That's an entire landscape of protein to water specific interactions, none of which we need to go into in any specific detail now.
But the one thing that we do need to realize and keep in mind as we go forward is that many of the biological processes in our body that involve the movement of molecules such as water and interactions with proteins are going to involve the bonding or lack of bonding between water molecules and proteins.
And anytime we're talking about bonding of one thing to the next at the level of chemistry or biology for that matter, because they're really the same thing, we're talking about whether or not there are electrons present or whether or not there are charges that are opposite or the same and on and on.
If you've ever heard of so-called reactive oxygen species, what are ROSs or reactive oxygen species or so-called free radicals or antioxidants, all of that is really just describing the presence or absence of charges that are bound or unbound.
So for instance, if you hear about free radicals, sounds pretty wild, free radicals, what are free radicals?
Free radicals can damage cells.
They don't always damage cells, but they can damage cells because they are essentially free electrons.
They are a charge that's sitting out there, not bound to anything and therefore can interact with the molecular structure of certain proteins and change those structures by binding to them or interfering with the normal binding processes of those proteins to water or to other things and in that way cause damage to those proteins and potentially damage to cells.
Now fortunately, our cells have ways to deal with those free radicals and those are called antioxidants.
Antioxidants are molecules that can arrive in different forms.
Sometimes we think of antioxidants as vitamins, but they are also present in other things as well that essentially bind up those free radicals or repair the bonds between cells so that the proteins are no longer undergoing these, let's just call them bad confirmations that damage the functioning of our cells.
So there are many different theories of aging.
There are many different theories of disease, but there is not a single disease either of brain or body that doesn't in some way involve the generation of what are called reactive oxygen species, these free radicals and the damaging of cells at the level of their individual organelles and so forth, nor is there a single disease of brain or body that has not been shown to benefit from having some antioxidant interference get in the way of that oxidative process.

So I realized today is pretty thick with nomenclature.
For those of you that haven't already realized it, what you're learning here is organic chemistry.
So you can feel pretty good about the fact that if you can understand the water molecule and understand a little bit about what free electron is, which is basically a charge that's out there that can potentially do damage and the interactions of things like reactive oxygen species and the ability of stable bonds to buffer against or repair certain damage to cells as we're describing it here.
Well then what you're essentially thinking about and what we're talking about is organic chemistry.
Now, since this is a discussion about chemistry as a service to try and understand the biological effects of water, keep in mind that water itself, believe it or not, can act as an antioxidant provided that it's bonding to things in the proper way, which requires that it get into cells in the proper amounts and rates, which requires that the temperature and pH of that water be correct and provided that there's enough water there and that that water isn't bound to other things.
It's not containing solids that are damaging and potentially that it's carrying some of the good things such as sodium or that there's potassium present, again, the so-called electrolytes that allow cells to function well.
So that's a bit of a trench of information and I don't want people to get overwhelmed or confused.
What I'm trying to do here is paint a picture of the biology of water, understanding that when you ingest water, drinking it down or when you breathe water vapors in the steam room or on a human day, that water is entering your system.
It's accessing your cells through these two mechanisms, diffusion across cell membranes, movement through aquaporn channels, and then once inside those cells, it's able to interact with and change the confirmation of different proteins and accelerate or slow down different cell reactions, everything from normal metabolism to blood pressure to damaged cells, depending on a number of different features of that water, as well as what the cells happen to be doing at any given moment.
So with that in mind, I'd like to turn our attention to how water, depending on its temperature, its pH, how much we drink or how little we drink, when we drink that water, et cetera, how that can impact the health, disease, and repair of different cells, tissues, and organs of our body.
I'd like to just take a brief moment and thank one of our podcast sponsors, which is Inside Tracker.
Inside Tracker is a personalized nutrition platform that analyzes data from your blood and DNA to help you better understand your body and help you reach your health goals.
I've long been a believer in getting regular blood work done for the simple reason that blood work is the only way that you can monitor the markers such as hormone markers, lipids, metabolic factors, et cetera, the impact your immediate and long-term health.
One major challenge with blood work, however, is that most of the time it does not come back with any information about what to do in order to move the values for hormones, metabolic factors, lipids, et cetera, into the ranges that you want.
With Inside Tracker, changing those values becomes very straightforward because it has

a personalized dashboard that you can use to address the nutrition-based, behavior-based, supplement-based approaches that you can use in order to move those values into the ranges that are optimal for you, your vitality, and your longevity.
Inside Tracker now includes a measurement of apolipoprotein B, so-called APOB, in their ultimate plan.
APOB is a key marker of cardiovascular health, and therefore there's extreme value to knowing your APOB levels.
If you'd like to try Inside Tracker, you can go to insidetracker.com slash huberman to get 20% off any of Inside Tracker's plans.
Again, that's insidetracker.com slash huberman to get 20% off.
Let's talk about how much water, or more generally speaking, how much fluid each and all of us should drink each day, and how much fluid to drink depending on our specific activities and environment.
Now, this is perhaps the most commonly asked question when the topic of water comes up.
How much water do I need to drink?
The other thing that comes up is a question, which is, can't we just follow our natural thirst?
That is, can't we just pay attention to when we're thirsty and then drink fluids?
And then that leads to the other question, which is, does the color of our urine provide any indication as to whether or not we are under hydrated, over hydrated, or hydrating correctly?
So let me answer each of these things one at a time.
And in the backdrop, I want to highlight the fact that there are many, many, if not dozens of hundreds of studies pointing to the fact that when we are dehydrated, our brain doesn't function as well, and our body doesn't function as well.
So what I'm attempting to do in that statement is throw a net around the enormous number of studies that have shown that even a slight state of dehydration, even 2% dehydration, can lead to a significant and meaningful impact that is a negative impact on our ability to, for instance, carry out endurance type behaviors.
So our ability to run on a treadmill and stop at the point where we feel that we can't continue is going to be negatively impacted.
That is, we will be able to perform less work for less period of time when we are even slightly dehydrated.
Likewise, our strength is reduced by even slight dehydration.
Likewise, our cognitive performance, including memory, focus, creative thinking, flexible thinking of different kinds are all significantly impaired when we are in states of dehydration.
Now that raises an additional question that deserves attention, which is, how do we actually measure dehydration?
Now you hear different things, like if you pinch the skin on the top of your hand and it takes more than three seconds to lay down again flat, then you're dehydrated.
You hear that, you hear, okay, if you are to press on your fingernail and see a change in the color of the tissue just below your fingernail, which indeed does happen.
And it does not go back to its original color within one to three seconds, then you're dehydrated.
You hear things like this.

If your ankles are swollen when you're wearing socks, you take off the socks and you can see the imprint of the socks on your lower limbs.
That means you're dehydrated.
You hear this kind of stuff and you should probably be wondering, is any of that true?
To some extent, it is true, although it can vary quite a bit by how old you are, whether or not your skin on the top of your hand tends to be looser or not, depending on whether or not you're leaner or not.
In other words, those are not absolutely objective measures of dehydration.
Now it is true that if normally you can pinch the skin on the top of your hand and it returns to its normal flattened position within about one to two or three seconds, and it does not do that within five or more seconds, there's a decent probability that you're a little bit dehydrated, that you need to ingest some fluid, or that if you press down on your nail and you see the depression causes a transition from kind of a pink color to a white color and then you release and it doesn't go back to its original pinkish color within a few seconds.
Well, then there's a chance that you're dehydrated, but again, these are not perfect measures of dehydration.
You may be surprised to learn and I was surprised to learn that most of the basis for these statements like even a 2% dehydration state can lead to significant reductions in cognitive or physical performance are based on not direct measures of hydration, but rather on measures of reductions in water intake, which is a different thing, right?
It's saying that ordinarily, a person of a given body weight needs X amount of fluid per day.
And when they get even just 2% less than that amount of fluid, then their cognitive and or physical performance is impaired rather than focusing on dehydration of tissues.
Now that might seem like a subtle distinction, but it's actually a meaningful distinction when you think about it.
However, it's a meaningful distinction that we can leverage toward understanding how much water or fluid we need to drink each day.
Now there we can really point to some solid numbers that believe it or not are fairly independent of body weight.
Now I say independent of body weight, I'm referring to the amount of fluid that most healthy adults need at rest, what do I mean by at rest?
I mean when not exercising and when not in extremely hot environment.
So I'm leaving aside you a desert ultra marathoners or people that are doing any kind of movement or living in environments that are very, very hot.
Here I'm mainly referring to people that live most of their daily life in indoor environments could be air conditioned or not air conditioned, heated or not heated.
What we're trying to arrive at here are some numbers that can work across the board because of course there are an infinite number of different conditions that each and all of you are existing in.
So I'm not going to attempt to give you a body weight by activity by environment by humidity formula calculation.
In fact, no such calculation exists.

However, there are formulas that can put you into very stable frameworks that is levels of water intake for periods of rest when you're not exercising and for when you are exercising that will ensure that you are hydrating with the one exception being if you are exercising or if you are living in very, very hot conditions and you're not heat adapted to those conditions.
So what are those numbers?
In other words, what is the answer to the question of how much fluid do we need each day?
And here I'm referring to fluid.
I'm not distinguishing between water, caffeinated beverages, soda, tea and so on.
I'll discuss that in a moment.
We can reasonably say that for every hour that you are awake in the first 10 hours of your day, this is important in the first 10 hours of your day, you should consume on average eight ounces of fluid.
For those of you that are using the metric system, not ounces, eight ounces of fluid is approximately 236 milliliters of water.
And for those of you that exist in the metric system and aren't used to thinking about ounces and vice versa, just think about a typical can of soda in the United States, it's 12 ounces.
In Europe, sometimes the cans of soda are a little bit smaller.
That's a whole discussion unto itself, but eight ounces of fluid, that is 236, let's just say 240 milliliters, because we don't need to be too precise here, of fluid on average every hour for the first 10 hours of your day, which translates to an average of 80 ounces of fluid for the first 10 hours of your day, or 2360 milliliters of water.
In other words, approximately two liters of water plus a little bit more for the first 10 hours of your day.
Now I want to be very clear that this does not mean that you need to ingest eight ounces or 236 milliliters of fluid on the hour, every hour for the first 10 hours of your day.
I'm certainly not saying that.
And in fact, most people are going to find that they're going to ingest water in boluses, that is they're going to have perhaps 16 ounces of water, 500 milliliters of water at one portion of the day.
And there may be a couple hours of later that they'll drink some more water or some more coffee or soda or some other beverage and another portion of the day.
I do think, however, it's important for most of us to take a step back and ask ourselves whether or not independent of any other activity or environmental conditions, whether or not we are in fact ingesting 80 ounces or basically 2.4 liters of water for that 10 hours of the day that spans from the time we wake up until 10 hours later.
Now why am I setting this 10 hour framework?
The reason I'm setting this 10 hour framework is that it turns out that your fluid requirements, even just at rest, are vastly different in the time from when you wake up until about 10 hours later as compared to the later evening and nighttime.
And here I'm referring to people that are not doing night shifts, but if you are requesting a number of how much fluid to drink independent of our needs for fluid for exercise, that's going to be eight ounces of fluid or 240 milliliters of fluid on average for every hour from the

time when we wake up until 10 hours later.
That's the simple formulation that should basically ensure that you're getting sufficient baseline hydration for the cells and tissues of your body.
Now if you are engaging in exercise, whether or not it's endurance exercise or whether or not it's resistance training exercise, you are going to need additional fluids in order to maximize the effects of that exercise and to avoid dehydration.
And there too, we have some excellent numbers that we can look to, excellent because they arrive from research.
And this is largely peeled from the episode that I did with Dr. Andy Galpin, professor of kinesiology at Cal State Fullerton.
We did a six episode series all about exercise, everything from strength training hypertrophy, endurance, nutrition, supplementation, recovery, everything related to exercise.
You can find all of that at hubermanlab.com and one of the components of those episodes that was discussed, but that some of you may have not heard, is that there is a simple formula for how much fluid to ingest on average.
Keep in mind this is on average when you're exercising.
And I refer to this as the so-called Galpin equation.
The Galpin equation states that you should take your body weight in pounds, divide that by 30, and that will give you the number of ounces of fluid to ingest every 15 to 20 minutes on average while exercising, okay?
Your body weight in pounds divided by 30 equals the number of ounces of fluid to consume on average every 15 to 20 minutes.
When I say on average, what I mean is, it is not the case that you need to stop every 15 or 20 minutes and consume that volume of fluid.
You could sip it from moment to moment, you could wait half an hour or an hour and then consume a larger bolus of fluid, a larger amount, although it is recommended for performance sake that you sip or consume beverages fairly consistently throughout your training.
One's ability to do that is going to depend on a number of things like gastric emptying time, whether or not that particular exercise you're doing, whether or not it's running or jumping is compatible with ingesting fluid on a regular basis or whether or not you need to do it at different intervals than every 15, 20 minutes, maybe it's every five minutes, maybe it's every half hour, you have to adjust for you.
But if you were to take the hour of exercise or the half hour of exercise or the three hours of exercise and ask how much fluid to ingest, it's going to be that Galpin equation of body weight in pounds divided by 30 equals the number of ounces for every 15 or 20 minutes.
And of course I can already hear screaming from the back, what about for those of us who follow the metric system?
And there there's a simple translation of the Galpin equation, which is that you need approximately two milliliters of water per kilogram of body weight every 15 to 20 minutes.
Again the Galpin equation converted into the metric system is going to be two milliliters of water per kilogram of body weight every 15 to 20 minutes on average.
I'm sure a number of you are asking whether or not hydration prior to exercise is also important.
It absolutely is.

And if you follow the numbers that I talked about before, approximately eight ounces or 240 milliliters of fluid intake per hour in the first 10 hours of waking, that should establish a good baseline of hydration heading into exercise, which then prompts the next question I often get, which is, is the amount of water that needs to be consumed according to the Galpin equation during exercise on top of or separate from that is, does it replace the amount of fluid that one needs at a basic level that eight ounces or 240 milliliters?
And there the answer sort of goes both ways.
I think if you're going to exercise, then obviously follow the Galpin equation in some way.
Again, you don't need to be ultra specific about this.
These are ballpark figures that will ensure hydration.
So we've set them a little bit higher, perhaps the needed to ensure more hydration rather than less.
But basically the short answer is if you're exercising for about an hour, most people are exercising for an hour or two, probably not more than that.
Most of my workouts are certainly the resistance training workouts last about an hour.
Well then you can replace the eight ounces or the 240 milliliters of water that's required at baseline with what you consume according to the Galpin equation during that bout of exercise.
The second question is if you are exercising in a heated environment, indoor outdoor, or you are somebody who tends to sweat a lot.
And by the way, we can all get better at sweating by sweating more sweat is an adaptation.
So if you sit in the sauna more, you're going to get better at sweating.
If you exercise more, especially if you wear more layers or if you do it in hotter temperatures or more humid temperatures, you're going to get better at sweating over time and sweating is an adaptation that helps cool your body.
If you are sweating a lot or you're in heat, how much fluid should you ingest in general?
I think it's safe to say that you may want to increase the values on the Galpin equation by about 50 to 100%.
So either increased by 50% or double those numbers if you're in a very hot environment or sweating an awful lot.
If you are sitting in the sauna, I highly recommend consuming at least eight ounces and probably more like 16 ounces of fluid.
So that translates again to about 240 or about 480.
Let's just round up 500 milliliters of fluid for every 20 to 30 minutes that you are in a hot sauna.
And then of course, people ask, well, how hot and it, okay, that starts getting really detailed and we can't distinguish between dry saunas and wet saunas.
And again, too many variables, but I would double your fluid intake for that hot environment exercise or for that hot environment sauna sit.
So if you are feeling dehydrated, okay, what does feeling dehydrated mean?
That actually has a definition that we can get into a little bit later.
But what we're really talking about here is if you are feeling as if your throat is dry, you are quote unquote, parched or you're very thirsty.

Well then there's absolutely no problem with ingesting more fluids of 16 ounces of fluid or 500 milliliters of fluid per hour while you're feeling parched.
My read of the literature is that thirst is a reasonable guide for when we tend to be dehydrated, however, it is the case that our thirst doesn't really keep up with our body's level of dehydration and we know that based on some really nice studies that have explored the amount of fluid intake compared to the amount of urination compared to the amount of physical output compared to the environment that one happens to be in.
These are sort of older studies in the realm of physiology.
But here's the basic rule of thumb that's going to work for most people.
If you are feeling parched, consume fluids.
Usually you consume fluids that don't contain caffeine or other diuretics, diuretics being substances that cause the release, the urination of fluid from the body and or if you are consuming caffeine either prior to or after bouts of exercise or even just at work or you work in a air conditioned or otherwise dry, cool or hot environment that you try and include some sodium and ideally sodium potassium magnesium, the electrolytes in that beverage.
It could be a little pinch of sea salt with some lemon to adjust the taste a little bit.
It could be an electrolyte drink of element or some other sort.
There are a lot of different types out there for most people drinking pure water.
And I realized that many people do just like the taste of pure water.
Chances are you're going to have enough electrolytes unless you're sweating quite a bit or you're exercising quite a lot and under conditions where you are consuming very few carbohydrates.
You're going to excrete more fluid.
If you are ingesting caffeine, whether or not it's from tea or coffee, I highly recommend increasing your non-caffeine fluid intake about two to one for every volume of caffeine.
So in other words, if you have a six ounces or eight ounces of coffee, you're going to want 12 to 16 ounces of fluid, ideally fluid with electrolytes or a little pinch of salt in order to offset that dehydration.
Well, hopefully those will provide good rules of thumb for what people want to do when they're just moving about their day.
Again, underscored by the fact that even slight levels of dehydration can really impair our cognitive and physical performance, largely by creating fatigue, but more often than not by creating brain fog.
You know, I get so many questions about brain fog.
Why do I have brain fog?
Why do I have brain fog?
There is a vast literature showing that quality hydration, meaning hydration that matches the demands of humidity and output, as described in the equations that we went over a little bit before, really can enhance clarity of focus and overall energy.
And we'll talk about why that is, but I'll just allude to it a little bit here.
The reason why ingesting sufficient fluids can enhance our ability to focus and in fact can reduce brain fog and can increase physical vigor and output is not mysterious to us.
We know that there are two mechanisms by which fluid intake triggers elevated levels of alertness.
And it all has to do with the so-called sympathetic arm of the autonomic nervous system, which is a real mouthful, but basically the sympathetic arm of the autonomic nervous system, as many

of you heard me talk about before, is the aspect of your nervous system that makes you more alert.
It has nothing to do with emotional sympathy.
It has to do with a bunch of neurons in the middle of your spinal cord called the sympathetic chain ganglia and some other related neural networks in your body, as well as regions of your brain like the locus ceruleus that release things like epinephrine and norepinephrine and make you more alert.
And in a kind of magnificent arrangement, or I think magnificent arrangement, when we have fluid in our gut and when our cells are well hydrated and believe it or not, when our bladder contains fluid within it, there is an elevation in activity of the sympathetic nervous system by way of two pathways.
One is mechanical.
In fact, we have so-called stretch receptors in our bladder and in our gut.
These stretch receptors have fancy names like TRP, trip channels as they're called or piezo, which are these stretch sensing channels.
This is the beautiful work of many laboratories, but in particular, David Julius and Ardem Padapuchin.
David Julius is at UC San Francisco.
Ardem is at the Scripps Institute.
They've discovered a bunch of channels and cells that sense things from cold to different mechanical pressure, including expansion of tissues, so-called mechanosensation.
And basically what it all boils down to is that when our bladder has some fluid in it, when our stomach has some fluid in it, and when our cells are sufficiently hydrated, they send information about the mechanical presence of that distention.
And here I'm not talking about being overly full or full chock-a-block full of fluid or your bladder feeling really, really full.
We'll talk about that in a moment.
But when we are sufficiently hydrated, there's a mechanical signature of that, which is the expansion of our tissues because it has more fluid in it.
And there are chemical signals as well, which is the movement of water across those aquaporin channels is actually understood at a biological level by ourselves and sends information to the areas of the brain that are associated with so-called sympathetic arousal and makes us more alert.
This is actually what wakes us up in the middle of the night.
If we have consumed too much fluid prior to sleep and we need to urinate, we wake up.
This is a mechanism that is not adequately developed in babies and young children.
This is why babies, young children often will wet their bed.
And believe it or not, both humans and in dogs, our ability to control urination voluntarily is something that we actually learn.
Babies just pee in their diaper, dogs just pee on the floor until their house broken or until a child learns to hold on to their urine until they go to the bathroom in a bathroom or particularly appropriate location outdoors or otherwise.
The point is that hydration of the body is signaled to the brain.
When we have enough fluid in the tissues of our body, when we've consumed enough fluid,

even if it hasn't already arrived to the cells and tissues of our body, that is signaled to the brain in the form of alertness.
And that alertness is what translates to the enhanced cognitive abilities that we have when we are well hydrated.
It's also what translates to our enhanced physical abilities when we are challenged with physical tasks.
So when you look out on the landscape of all these studies that have shown impairments in physical or cognitive performance under conditions of even slight dehydration, that all makes sense because our cells need fluid and we need water.
But it also prompts the question of, well, does being well hydrated actually make our brain and body function better in the context of physical and cognitive performance?
And indeed the answer is yes.
Now earlier we were talking about these equations that you can apply.
And again, I really want to emphasize that these equations were not meant to be followed down to the decimal point.
They were really meant and are meant as crude but sufficient guides for you to make sure that you're getting enough hydration depending on your levels of activity and at rest.
If you recall, when we talked about those equations, I said you need about eight ounces or 240 milliliters of fluid per hour for the first 10 hours of your day after waking.
Now, why did I say for the first 10 hours?
Well, it turns out that the filtration of fluids from your body, which is accomplished, of course, by your kidneys and by way of your bladder and the excretion of fluid out your rethra, so-called urination, is strongly, strongly circadian dependent, meaning the cells of your kidney and the cells even of your gut.
In fact, all the cells of your body, but especially the cells of your kidney, which filter the fluid that comes into your body and that makes certain hormones like vasopressin, which is anti-diuretic hormone, all of that functioning of the kidney is under strong regulation by so-called circadian and clock genes.
Circadian clock genes are genes that are expressed in every cell, but that in certain cells of the body, very strongly impact whether or not that organ, in this case, the kidney, is going to be activated, meaning functioning at a very high level or at a reduced level.
We can make all of this very simple by simply stating what's contained in this beautiful review that I'll provide a link to if you want to learn more called circadian rhythms in the kidney, and basically what is known is that for the first 10 hours after waking, your kidney is filtering fluid within your body at a very rapid rate.
There are a number of different cell types that do that, but they are basically taking that fluid, pulling out any contaminants using hormones such as anti-diuretic hormone, vasopressin, to adjust whether or not you're going to hold on to fluid or release more fluid from your body in the form of urine, depending on the salt concentration, depending on how much fluid you need, your work output, the conditions you're in, all of that.
However, at about 10 hours after waking, your kidney really starts to reduce its overall level of functioning.
Now, that doesn't mean that your kidney cannot filter fluid 11 or 12 or 16 hours after waking, but it becomes far less efficient at doing so, and thank goodness it does because you

do not want your kidney filtering fluid at the same rate at midnight, assuming you wake up at say seven or eight or nine AM, that it was filtering fluid at 10 AM.
In fact, we can say that if you want to reduce your nighttime waking in order to urinate, which is a common, common question and concern that many people have, how can I avoid waking up in the middle of the night to urinate?
There I say, it's perfectly normal to wake up once, maybe twice each night to urinate, but if you want to reduce the number of times that you wake up in order to urinate across the night, maybe even make that number zero times, you will greatly benefit by doing three things.
First of all, make sure that you're hydrating sufficiently during the daytime per the equations that we talked about earlier.
That will ensure that you are not excessively thirsty in the evening and therefore consuming a lot more fluid.
Second, and related to that first point, is that you do want to reduce your fluid intake at night provided you hydrated sufficiently throughout the day, and believe it or not, the rate at which fluid moves from your gut and into the cells and tissues of your body and then from your bladder into urine is determined not just by the volume of fluid you ingest, but also the rate at which you ingest that fluid.
You might be thinking, that's crazy, that makes no sense at all, right?
If I drink a ton of fluid slowly, doesn't it still mean that I'm going to urinate a ton?
Yes and no, it also stands to reason that you might ask, if I ingest very little fluid, but I do it very fast, is it going to be the case that I'm going to urinate it out very quickly?
Well, yes and no.
The point is that the fluid filtration systems of your body that range from the gut to the bladder and include the kidney, of course, depend not just on the volume, but on the rate of fluid that you ingest because of those McKenna sensors that we talked about earlier.
If you gulp down a bunch of fluids, you are going to excrete those fluids more quickly than if you sip them slowly, excuse me, sip them slowly.
So here's what I recommend throughout the day when you're trying to get your adequate yield of water or other beverages, feel free to gulp that fluid or sip it.
I'm a gulper, not a sipper, but many of you are going to be sippers, not gulpers.
Consume fluid at the rate that feels right to you, but feel comfortable gulping that fluid.
However, in the evening, if you are somebody who has challenges with waking up excessively in the middle of the night, reduce your fluid intake provided you've hydrated properly throughout the day, and I suggest consuming no more than five, maybe eight ounces of fluid between the time of 10 hours after waking and when you go to sleep.
Again, if you're very thirsty or you under hydrated or it's very hot, feel free to ingest more fluid, please, but most people will find that if they reduce their fluid intake to about five ounces or less of fluid in that later part of the day after 10 hours of having woken up and before sleep, and they sip those beverages as opposed to gulping them, that they will have fewer bouts of waking up in the middle of the night to go to the restroom

and ideally zero.
Let's talk about tap water.
Here I have to take a deep breath, not a deep gulp, but a deep breath because in researching tap water and what's contained in tap water in different regions, not just in the US, but around the world, I confess the picture is a pretty scary one.
I want to be clear.
I'm not somebody who naturally orients towards fear or conspiracy theories, however, in researching tap water for this episode by way of looking at the peer reviewed research, meta analysis, reviews, specific research articles where specific hypotheses were tested and in talking with experts in toxicology and so on, it's a pretty grim picture, frankly, when one looks at what's contained in most tap water and whether or not the compounds that are contained in tap water are present in sufficient concentrations to negatively impact our health.
And the bad news is that much if not all tap water, believe it or not, much if not all tap water contains things that are bad for the biology of our cells.
There is a silver lining, however, and the silver lining is that very simple steps that are very inexpensive can be used to adjust that tap water to make it not just safe to drink, but that makes it perfectly fine to drink.
So that's the good news and we'll get to that in a moment.
If you are somebody who is interested in whether or not tap water contains things like endocrine disruptors, hormone disruptors that can negatively impact reproductive health in males or females or both, there's a wonderful review, wonderful because it's so thorough, although the news isn't great, it's very thorough, which is great, which is entitled endocrine disruptors in water and their effects on the reproductive system.
This is a review from 2020 that analyzes water from a bunch of different sources within the world and essentially focuses on a few key components.
First of all, it focuses on the concentration of minerals that is magnesium and calcium within water.
Many people don't realize this, but so-called hard water sounds terrible, right?
But hard water is water that contains magnesium and calcium, which turns out to be a good thing.
Some water contains more magnesium and calcium, other water contains less.
They looked at the presence of magnesium and calcium because that is going to impact the pH of water.
In general, the higher concentrations of magnesium and calcium in water, the higher the pH, that is, the more alkaline that water is and the lower levels of magnesium and calcium, the more acidic or lower pH that water tends to be.
The other thing that this review addresses is the concentration of so-called DBPs, Dog Bulldog Porcupines, DBPs, which are disinfection byproducts contained in water.
Obviously, local governments, the government wants your drinking water to be clean.
They don't want contaminants in it.
They don't want sewage in that water.
They don't want chemical contaminants that are going to make people immediately sick.
They treat water, water treatment plants, treat water with disinfection products and those disinfection products create things called disinfection byproducts.

The presence of those DBPs or disinfectant byproducts can strongly impact the pH of water by way of changing the concentrations of magnesium and calcium.
Put differently, I do believe that governments are trying to provide people with clean water, but in doing so, oftentimes we'll introduce things to that water that are not good for us.
Now, it's very clear that DBPs can cause endocrine disruption in ways that are not good for reproductive health.
I did a very long, in fact, four and a half hour episode on fertility and vitality.
That was male and female fertility, by the way, and vitality that, again, you can find at hubermanlab.com that talks about all the biological processes involved in the generation of healthy eggs and sperm and creating healthy embryos, implantation embryos and so forth.
It's very clear that DBPs have been shown to disrupt ovarian functions, spermatogenesis and fertility outcomes, even at concentrations of DBPs that are present in drinking water that comes from the tap.
Now, does that mean that you shouldn't drink tap water?
Well, the answer to that is it depends.
What does it depend on?
Well, it depends on several things.
First of all, I highly recommend that everybody go online and put in your zip code and ask for a water analysis of water that comes out of the tap in that zip code.
This is something that is readily available online, at least to my knowledge.
And unfortunately, there's no specific one site that I can send everyone to to get an in-depth analysis of the drinking water that comes out of your tap.
However, I highly recommend that you go online and put in your zip code or municipal area code and figure out whether or not your water contains X amount of DBPs or Y amount of DBPs.
Now, of course, you're going to get a bunch of values back.
And unless you're a toxicologist, probably not going to know what those values mean.
But what you're really looking for is whether or not there are high, low or moderate levels of fluoride in that drinking water.
Why do I say that?
Well, there are studies that show that the concentration of fluoride in drinking water is of particular concern for the thyroid hormone system of the body.
Now, thyroid hormone has a lot of different roles in brain and body.
And thyroid hormone is very important for everything from metabolism to levels of energy.
When thyroid levels are disrupted or thyroid receptors are disrupted, it can lead to depression.
When thyroid hormones are optimized, it can lead to optimal mood.
If there is such a thing, but in other words, it helps keep your mood elevated.
It relates to everything from sleep to reproduction, thyroid hormone is involved in many, many things, including bone health and tissue health generally.
So essentially every biological process in your body is impacted by thyroid hormone.
And there's a study that I'd like to highlight, which was published in 2018.
And the title of the study is impact of drinking water fluoride on human thyroid hormones.
This was a case control study.

So this is not an extensive analysis of many individuals.
However, what it shows is that fluoride negatively impacts thyroid stimulating hormone and so called T3 levels.
So you have thyroid hormone T3 and T4, even in the standard concentrations that are present of, and here's an important number, 0.5 milligrams per liter.
Okay.
So if you can get ahold of the fluoride concentrations in your tap water and find out whether or not the concentrations are at below or exceed 0.5 milligrams per liter, what you will find is that even just 0.5 milligrams per liter of water can disrupt thyroid function.
And this is going to be a particular concern for people to have familial, so genetically related thyroid issues or that are concerned with keeping your thyroid hormone levels healthy, which I think is everybody.
So I am telling you that you should try and get ahold of some data about the water that comes out of your tap.
If you intend on drinking tap water and probably even if you don't just know what's in your drinking water, your local government should provide that information and or it should be readily available online.
And in particular, I think it's worthwhile to address how much fluoride is present in your drinking water.
Again, I don't want to create a lot of scare.
I'm not trying to trigger fear here.
I do think, however, by way of reading this review, by way of reading the paper that I just referred to a moment ago.
And links to these are going to be provided in the show note captions that there is extensive evidence that elevated levels of fluoride in drinking water are simply not good for us.
Now that could open a whole discussion of why fluoride is in our drinking water in the first place at all.
But leaving that aside, it seems to me that most everybody should know how much fluoride is in their drinking water.
And ideally everybody, yes, everybody is filtering their drinking water.
Now that raises the question of how best to filter drinking water.
And that brings an answer of it depends on a couple of things.
First of all, how healthy or unhealthy do you know yourself to be?
So if you're somebody who has no health issues, you have plenty of vigor, you're sleeping well at night, you have no autoimmune disease, you're not aware of any health concern minor or major, well, then perhaps you're somebody that doesn't want to filter your water.
I would argue that why wouldn't you employ some very low or even zero cost approach to filtering your water?
There are going to be other individuals who are suffering particular ailments of brain or body or both that absolutely should be filtering their drinking water if they're getting their drinking the water from their tap because it is pretty well established now that tap water contains a lot of these disinfectant byproducts as well as in most cases, exceeding the threshold of fluoride that we know to be healthy for us.

How should you filter your tap water?
Well, you have everything ranging from the so-called Brita type filters to these are going to be carbon type filters or other filters that you essentially put over a container or a compartment where you can pour the water over it and goes into the compartment below.
Will those work?
Are they sufficient to filter out the disinfectant byproducts?
The general answer is yes, provided you change the filters often enough.
However, it is not thought, unfortunately not thought that they filter out sufficient fluoride.
So what I highly recommend is depending on your budget that you go online and you search for at home water filters that can filter out fluoride.
There are a number of straightforward and inexpensive tools to do that.
And here I don't have any relationship to any of the water filters or things that I'm going to mention now.
I want to be very clear about that.
There's no brand code or affiliation here.
I'm simply trying to direct you to resources that will allow you to filter your tap water for it to be more safe for you to consume in a way that meets your budget with the understanding that people have very different disposable incomes.
So the range of costs here is going to be pretty tremendous.
I just want to get that out of the way for a sec.
You know, there are water filters that you can use repeatedly.
So these are what I'll refer to as picture filters that are less than $100.
Now, keep in mind that that's a one time purchase except for the replacement of the filters, which fortunately doesn't have to be done too often.
So there are different filters.
I'll provide a link to one that I found that is at least by my read of the lowest possible cost.
So this is the so-called clearly filtered water pitcher with affinity filtration.
So this is a filter that can adequately remove fluoride, lead, BPAs, glyphosates, hormones, and some of the other harmful things that are contained in most tap water.
Again, I do realize that for some people, even an $80 US dollar cost is going to be prohibitive.
But do realize that what you're doing here is you're purchasing a unit that can be used repeatedly over and over.
The reason why it's lower cost than some of the different filtration approaches that I'll talk about in a moment are that you can't really put all the drinking water that you would use, say for an entire week or for an entire month in one pitcher.
You're going to have to repeatedly pour water into the pitcher in order to filter it.
Now, as I mentioned before, the range on water filter costs for filters that can adequately remove fluoride and all the other things that you want out of your top water is immense.
In fact, you can find whole house water filters that are $2,000 or more.
Again, these are going to be filters that are going to be in your garage or in a laundry room that are going to basically pull from the piping system of your house and deliver purified water.

Technically, it's not purified, but that's removing these contaminants and fluoride from all the sinks in your house so you could effectively drink from any or all things in your house.
That's what explains the higher cost.
I think most people are probably not going to have the disposable income or have the opportunity to include one of these whole house filters, although if you do have the means and it's important to you, you could do that.
Then there are going to be what I would call intermediate systems.
Systems that cost somewhere between $200 and $500, probably one of the more common ones or popular ones is a so-called Berkey filter system.
These are filter systems that, again, remove the things that you want removed from your tap water and they can do it at higher volumes and they're typically countertop units.
They don't require any plug-in typically or they only require brief plug-in and electricity and they're going to filter out many, many liters or tens of liters of water so that you can always have access to that clean filtered water any time or day or night without having to pour over into the pitcher.
I mentioned these different options because, again, I realized that people have different levels of disposable income.
As far as I know, there's no tablet or simple mechanism that can be purchased as a transportable pill that you can just simply throw in water and remove the contaminants.
If anyone is aware of one that can adequately remove fluoride and other contaminants, please put in the comment section on YouTube.
That'd be the best place so that I and everyone else can see it.
But hopefully the mention of the different filtration systems that I mentioned would give you some choices that I would hope would fall within the range that one could potentially afford.
An important note about filtration.
Just as in our body, there are mechanisms to signal mechanical changes and chemical changes that occur in our gut, in our brain, et cetera, elsewhere and in general, both mechanical and chemical changes are signaled across the body to invoke different changes, whether or not those are a response of the immune system or to make us more alert or more asleep, et cetera.
So too, filtration capitalizes on mechanical and chemical filtration.
What I mean by that is when you run a fluid, water or any other fluid through a filter, those filters are doing two things.
They are physically constraining which molecules can go through by creating portals, pores that allow certain size molecules to go through and not others and almost always they contain certain chemicals themselves.
Those filters have been treated with certain chemicals that neutralize certain other chemicals.
So you may be wondering how when you filter water, magnesium and calcium could get through but fluoride doesn't.
And that's because these filters have been very cleverly designed in order to neutralize fluoride or to prevent large molecules such as sediment and dirt, which is kind of easy to imagine being filtered, but also to allow certain small molecules like calcium, which is smallish or magnesium, which is smallish to still pass through into our drinking water.

And this is wonderful because what it means is that by filtering our water using any of the methods that we talked about before, you're still going to get whatever magnesium and calcium was present in that water while still adequately removing the fluoride and other disinfectant byproducts.
Now what if you can't afford any of those options?
Okay, well, here you have an interesting zero cost option.
It's not as good as the other ones of filtering that water, but it is an option.
And I do think it's important to give options to people who don't have any disposable income for the purpose of filtering their water, which is to draw a gallon or five gallons or maybe even more tap water out of the tap and put it into some, some container, some vessel, so it could be one gallon, five gallon, 10 gallon container.
And then to let that tap water sit for some period of time to allow some of the sediment to drop to the bottom.
Now you might say, well, there's no sediment.
There's nothing contained in that tap water and it isn't fluoride diluted in the water.
And indeed the answer to that is yes, however, there is some evidence that letting tap water sit out at room temperature and outside the pipes that deliver that water can help remove some, not all of the contaminants in that water.
If however you are filtering the water using any of the methods that I talked about a few moments ago, you do not need to do this.
Okay, I realize there's a whole world out there of people who insist on putting their water in the sun or only keeping it in certain containers and putting it out for a few days before they get ingested.
That to me seems a bit extreme if you want to do that, be my guest, but I don't think most people need to do that.
However, I do believe that for people who have zero disposable income to devote to paying for any kind of filtration system for their tap water, they're taking that tap water and putting it into some container at room temperature and keeping it at room temperature for a half day or a day or more, and then pouring off the top two thirds of that water into another container and consuming the water from that second container is going to remove some, not all of the contaminants that one would need to be concerned about.
And here I should mention something that I neglected to mention a few moments ago.
If you're going to do this zero cost option and let the water sit out for a bit, you would want that water to sit uncapped, sorry, I should have mentioned that before, uncapped.
Of course, trying to keep things from falling into that water.
In fact, you could even put a little bit of cloth above it, so you don't want things falling into that water, but you want certain things to be able to evaporate off.
And you also want some of the sediment to drop down.
And the reason why this process of letting water sit out would work at all is because many of the contaminants contained within water are not present because of the source of that water or even the treatment of that water, but rather because of the pipes that that water arrives to your glass or the pot that you have from.
Okay.
And here again, there's an infinite number of variables.

So some people are living in buildings for which the pipes are very, very old, but very, very clean, believe it or not.
Some people are living in newer buildings and structures that have new pipes, but for which the seals between those pipes contain things that are not good for you to consume.
So by letting water sit out for a while, you're able to remove some of the contaminants present within the pipes of your home and the building and even the pipes that lead to your home or apartment.
Now, some people get really obsessed with this whole tap water thing and really want to find out all the details about the pipes and what sorts of hard metals and how much magnesium and how much calcium are present in their water.
There are ways that you can test your drinking water for those sorts of things.
Most people I realize, including myself, are simply not going to do that.
If you want to know what I do, I tend to drink water that is filtered through one of these lower cost filters.
Or if I'm going to be consuming a lot of fluid, I will drink certain kinds of fluid that later I'll tell you, I've been doing an experiment for sake of this episode, looking at so-called molecular hydrogen water, which sounds very fancy and esoteric and almost a little wacky, but it turns out has largely to do with the amount of magnesium and calcium and the pH of that water.
So if you are somebody who has a very low budget or simply just wants to spend a very small amount of money and try and still drink tap water, there is absolutely a way to do that safely, but it does require a few of these steps.
So on the topic of magnesium and calcium, this relates, as I mentioned earlier, to the quote unquote hardness of water.
So what of the hardness of water?
Is it better to have more magnesium and calcium in your water or less?
Some people don't like the taste of hard water.
They prefer the taste of water that has less magnesium and calcium.
However, there I would encourage you to take a step back and consider some of the literature.
In fact, I'll mention a paper in particular now published in 2019, which describes the quote regulations for calcium, magnesium, or hardness in drinking water in the European Union member states.
It turns out in Europe, they do very detailed water analysis, and that's present in a number of really high quality scientific publications.
This was a paper published in regulatory toxicology and pharmacology, and they cite a number of different references in the introduction that, for instance, and here I'm quoting, statistically significant inverse association between magnesium and cardiovascular mortality.
Now again, that's an association.
This is not causal, but higher magnesium in water, lower cardiovascular mortality.
They go on to say the highest exposure category, which are people consuming drinking water with magnesium contents of 8.3 to 19.4 milligrams per liter.
Again, when you get your water analysis, you can compare against some of these values was significantly associated with decreased likelihood of cardiovascular mortality by 25% compared with people consuming magnesium content of 2.5 to 8.2 milligrams per liter.

What this basically shows, and by the way, the reference to that I'll also provide a
link to in the show note caption, what this basically states is that higher magnesium
containing water, and it turns out higher magnesium and calcium in containing water,
so-called harder water may not taste as good to you, but turns out to be better for you.
Now whether or not it can prevent you from getting cardiovascular disease, I don't know.
In fact, I would probably just state no, it probably won't prevent you from cardiovascular
disease.
You still need to do all the other things that are important for avoiding cardiovascular disease
and cerebral vascular disease.
For that and what to do in order to avoid cardiovascular disease, I strongly encourage
you to listen to the episode with Dr. Peter Atia that's coming out in a few weeks that
gets deep into that topic and the actionable items for avoiding cardiovascular disease.
But basically as this study quotes, there is a growing consensus among epidemiologists
and epidemiological evidence along with clinical and nutritional evidence that's strong enough
to suggest that new guidance should be issued in terms of how these different sources of
tap water should enhance not deplete the amount of magnesium and calcium in that water.
Now this ought to raise a very important question in all of your minds, which is why is it that
magnesium and calcium concentrations are relevant to cardiovascular disease?
Is it something about what magnesium does in cells or what calcium does in cells?
Are we all magnesium and calcium deficient?
Well, it turns out that's not the case.
The major effect by which magnesium and calcium in water are likely to impact things like blood
pressure or cardiovascular disease and other aspects of cellular function turn out to be
somewhat cryptic, but we can make that cryptic aspect very clear by saying that when we have
more magnesium in particular, but also calcium present in our water, so-called hard water,
you increase the amount of hydrogen in that water, it becomes what we call hydrogen rich,
and the pH of that water is increased.
Now again, this does not mean that we are trying to change the pH of the cells of our
body in any kind of meaningful way.
In fact, we don't want to do that.
We want the pH of the cells of our body to stay in particular ranges as I mentioned earlier,
but having more magnesium and more calcium in our water, that is increasing the hardness
of our water, changes the pH of that water, and it turns out that the elevated pH of water,
that is pH of water that tends to be somewhere between high sevens, so we could say 7.9 up
to even nine or 9.2 is going to be more readily absorbed and is going to more favorably impact
the function of our cells than lower pH water.
Again, I want to restate this because I'm a little bit concerned that maybe a clip of
this is going to be taken and sent elsewhere and someone will get the impression that I'm
saying that we actually want to drink high pH water, that we all need to buy expensive
high pH water, turns out that's not the case.
If you're consuming tap water from a location where levels of a magnesium are sufficiently
high in that tap water, again, where the level of magnesium is 8.3 to 19.4 milligrams per
liter of water, that is if the water coming out of your tap is hard enough, well then
chances are you don't need to enhance the pH of that water or change its magnesium concentration.

If however, the water that you're drinking from the tap filtered or not, I would hope filtered, contains less than 8.3 milligrams per liter of magnesium, well then chances are the pH of that water is going to be low enough that it's not going to be lending itself to some of the favorable health components that higher pH water can.
Notice I did not say that lower pH, aka more acidic water, is bad for you.
I didn't say that, I said that higher pH water can be good for you.
So let's talk about how and why higher pH water can be good for you and some of the best and in fact very inexpensive sources of higher pH magnesium enhanced or simply tap water that contains sufficient magnesium can be used and accessed.
Many of you are probably wondering whether or not you can simply boil your tap water and thereby decontaminate the tap water.
Where I want to caution you, it turns out that some of the contaminants present in water are actually made worse by heating water and again I don't want to open up a whole catalog of different fears.
I like, all of you I presume, use water to cook, pasta, rice, because I'm an omnivore, I do consume those things.
I confess if I make your baumate or any kind of tea or coffee, I tend to use a higher quality water source than tap water even if that tap water is filtered because I like the taste far more if I use a really good source of water and again, because I'm not consuming those beverages in enormous volumes, that becomes a relatively inexpensive endeavor.
But I would caution people against using boiling or heating of water as the only method to decontaminate their tap water and instead to also rely on some of the filtration systems that I talked about before.
And as long as we're talking about the temperature of water, there is sort of an ongoing debate online.
It's not a huge debate, but a number of people engaged in this debate as to whether or not drinking really cold water or room temperature water is better for you or worse for you.
This is a tough one to resolve.
It turns out that if water is very, very cold, that is if you drink it and you can feel that cold water making its way down to your gut and you can actually feel it as cold within your gut and that's sort of a, you know, back of the envelope or I should say direct within the gut measure of a cold versus body temperature water, that it is going to be slower to absorb.
That is, you're going to feel it sloshing around in your stomach for a bit longer than if you were to consume water that is slightly warmer.
Now that is not to say that you should ingest warm water or room temperature water.
However, many people find that when they drink very cold water or ice water, that indeed it can alter the kind of a sensation of the lining of their stomach in ways that at least to them feel like it's altering their digestion.
And that makes sense.
The cells that line the gut are very temperature sensitive.
You want this.
So for a number of reasons, including not consuming food that is excessively hot or cold or damaging your gut, but in general, most people know the temperature of fluid that they want to ingest and ingest that temperature of fluid.

So most people, for instance, on a cold day want a warm or hot fluid.
Does that mean that you're not going to absorb that warm or hot fluid?
No, of course it doesn't.
You're going to absorb that fluid one way or the other.
So drink fluids at the temperatures that are to your liking in that moment.
In other words, what you desire in that moment.
And don't worry so much about trying to avoid cold beverages or trying to make sure that you're always consuming room temperature water as opposed to cold water.
So now with your understanding of hard water, soft water, magnesium, the relationship between magnesium, calcium, and the pH of water, and remember our earlier conversation where we talked about how higher pH water is actually going to move out of the gut and into the body a bit more readily and across those aquaporin channels more readily than lower pH, more acidic water.
Well, that raises the question of whether or not all these different forms of water that are out there, reverse osmosis water, distilled water, double distilled water, deuterium depleted water, alkaline water as it's often called, whether or not any or all of that has meaningful health outcomes.
Here we can address some of those items pretty quickly.
For instance, distilled water and double distilled water is essentially distilled of, that is, it has magnesium and calcium removed from it.
So my recommendation would be to not drink distilled water.
There may be specific circumstances where somebody has very high levels of blood magnesium or calcium or calcium stores within the body that would necessitate them drinking only distilled water, but that seems like a very isolated kind of niche case.
So in general, consuming distilled water is just simply not necessary.
Now in terms of reverse osmosis water, what is reverse osmosis water?
Reverse osmosis water is water that has been passed repeatedly through a series of filters that are designed to remove the kinds of contaminants we were talking about earlier.
So some of the basic contaminants like disinfectant byproducts, fluoride and some other large and small molecules that leaves the water ideally still containing magnesium and calcium, although there's some evidence that reverse osmosis water can deprive water of some of the magnesium and calcium.
So if you are going to use reverse osmosis filters and drink reverse osmosis water, you want to make sure that you're still getting the magnesium concentrations present in that water that we talked about earlier.
But in general, reverse osmosis water is considered safe, but, and for many people this is going to be an important, but, but very expensive to access the reverse osmosis filters require a lot of changing in the filters, purchasing reverse osmosis water in its stable form within containers.
These are typically glass containers is going to be pretty expensive and prohibitive for most people.
That said, there are a number of people out there that really like the taste of reverse osmosis water.
They report it as feeling more smooth.

They think of reverse osmosis water as quote unquote giving them energy.
To be quite honest, there's no direct studies of the subjective sensation of water in the mouth and in the gut and its relative health effects.
Again, the smoothness of water as one drinks it and goes down the gut really has no direct relationship to the quote unquote hardness or softness of water.
I know that's going to shock a number of you.
You probably think, well, hard water is going to be hard to drink and it turns out that's not the case.
In fact, many people find that with elevated levels of magnesium and calcium and water, it actually tastes smoother or softer in their mouth.
So hard water tastes smooth or soft.
I know it's all very counterintuitive, but I think it's important to point this out because a number of times you'll hear or read about filtering water so that it tastes smoother and better and oftentimes that's happening because the quote unquote hardness of water that is the concentrations of magnesium and calcium are actually increasing.
So if you're somebody who's curious about reverse osmosis water and you can afford the filters or the reverse osmosis water already pre-filtered, please be my guest.
Drink it.
I'm certainly not trying to prevent anyone from drinking it.
But there's no peer-reviewed evidence that I am aware of that conclusively shows that drinking a reverse osmosis water is far better for us than drinking other types of water provided the other types of water are adequately filtered of fluoride and the sorts of disinfectant byproducts that we talked about earlier.
So what about hydrogen water?
You may have heard of this or hydrogen enriched water or electrolyzed reduced water as a way to access hydrogen enriched water.
All this might sound pretty crazy to some of you.
Now, fortunately for sake of today's discussion, we can take a number of the different categories of let's call it unique categories of water that have been described, including deuterium depleted water.
And by the way, deuterium is something that relates to the presence of hydrogen ions in water and put very simply water that is extracted from sources that are closer to sea level tend to have more deuterium in them than water that is extracted from sources further from sea level.
So up in the mountains, for instance, and from springs further away from oceans as you get closer to sea level, the sources of water separate from seawater tend to have more deuterium, which relates to the enrichment or lack of hydrogen within that water or free hydrogen within that water.
I warned you, this was all going to sound pretty niche and that we were going to get a little bit into the chemistry.
But now I'm going to make it all very simple for you, at least for the non aficionado.
Just reduced water, which is a method of using electricity to alter the confirmation of the water molecules and their rates of movement as well, as well as so-called hydrogen rich water or hydrogen enriched water or deuterium depleted water, all have the property of having

higher levels of pH than other forms of water such as distilled water, reverse osmosis water, and generally higher pH than the kind of water that comes out of your tap, unless you live in a region where your tap water has very high levels of magnesium in it, which does occur in certain regions of the world, but is not that common.
More typically, the water that comes out of your tap does not have enough magnesium, meaning not as much magnesium in it as you would like.
And this, I believe, explains in a fairly straightforward way why there is such an appeal of these pH enhanced or alkyline waters or electrolyzed reduced water or deuterium depleted water.
There are a couple of reasons, but first of all, anytime someone is consuming a specialized form of water, chances are it's going to be filtered of the disinfectant byproducts, fluoride, and the other things that you really don't want in water.
So already the water is going to be cleaner than would be coming out of the tap.
So that's going to indirectly explain a number of the so-called health benefits, both subjective and perhaps even objective, as we'll talk about, that can result from consuming these other, let's say, more esoteric forms of water, at least not of simple tap water.
However, if you look at hydrogen or hydrogen enriched water, you really need to take a step back and ask, what is that?
What are we really talking about?
Because it turns out that you can create hydrogen enriched water by putting tablets of magnesium itself, small amounts of magnesium dissolving those in water.
It will give off a kind of gaseous solution.
You'll see a bunch of bubbling in there.
You certainly want to dilute that tablet and then consume the water.
And yes, it's true what you've heard about in red from these commercial sources.
You do want to consume that water within about five to 15 minutes after that tablet completes dissolving.
Now, why would you do this?
And I should say that I have now started doing this, not because I necessarily think that it's so necessary or so beneficial.
I'll talk about my experience in a moment.
I did it in anticipation of this episode because I was researching water and hydrogen enriched water and all these alkaline waters.
And what became very clear to me based on reading a fantastic two-part review.
It's a very extensive review entitled, at least the first part is entitled, electrolyzed reduced water.
Molecular hydrogen is the exclusive agent responsible for the therapeutic effects.
And then there's a second part to this review.
This is how extensive is entitled, electrolyzed reduced water.
Number two, safety concerns and effectiveness as a source of hydrogen water.
What this review, which we've linked to in the show notes, points to is that all of the health benefits of these different forms of water that you hear about out there, deuterium depleted, hydrogen enriched, et cetera, all seem to boil down.
No pun intended, no boiling included, I should say, to the elevation in hydrogen that translates

into, and here's the really meaningful change, the elevation in pH that occurs when you hydrogen enriched water.
Now, there are not a lot of clinical studies looking at hydrogen enriched water, but they're starting to be more than a few.
And one that I'd like to point out and that we'll link to was published fairly recently, which is entitled, hydrogen rich water reduces inflammatory responses and prevents apoptosis.
This is naturally occurring cell death during development and is generally used to describe cell death of the body.
Sometimes this can be good cell death, by the way, removing cells that need to be removed.
Again, the title of the paper is hydrogen rich water reduces inflammatory responses and prevents apoptosis of peripheral blood cells in healthy adults, a randomized double blind control trial.
Now this paper looked at the effects of drinking 1.5 liters per day of hydrogen enriched water for a period of four weeks.
They did find significant positive benefits of reduced inflammation and they found these changes by way of analyzing things like interleukin six and some of the other interleukins, which are markers of inflammation.
They controlled very nicely for the fact that people were still consuming other forms of water and liquid and coffee, et cetera, although they made sure that they weren't consuming too much coffee and soda in addition to this hydrogen enriched water.
But what this paper shows is that indeed increasing the free hydrogen in water can improve certain health metrics in these cells.
And this is in keeping with some of the subjective reports that people have stated out there and that I myself experience, I have to say that by drinking hydrogen rich water, which I'll tell you how to do fairly inexpensively in a moment, you do get the subjective experience of having more energy of feeling better, quote unquote.
Now keep in mind, of course, the placebo effect is a very real and powerful effect.
So it could just be placebo, although in this paper, they did, of course, include a placebo group so people didn't know if they were getting hydrogen rich, rich water or non hydrogen rich water.
I should also mention that the improvements in health metrics that they observed in this study were only observed for individuals older than 30 years old.
Why that is?
I don't know.
One of the questions these authors came to in terms of how these individuals older than 30 achieved lower levels, or I should say reduced levels of inflammation and improved markers of other aspects of biological function is that the hydrogen water improved the biological antioxidant potential of certain cell types.
And again, the cell types that they mainly focus on were these peripheral blood cells in this particular study.
Now how could this be?
Why would this be?
So back to our earlier discussion about reduction in reactive oxygen species, so-called ROSs and reductions in free radicals that can damage cells.

So if all of this is sounding very convoluted, I can understand why.
However, what I like about this study and the two reviews that I mentioned a moment ago is that these studies don't really say that hydrogen rich water is what's essential.
What these studies really point to is that the changes in pH of water that enhancing the hydrogen in water can create is what leads to the enhanced either absorption and or ability of cells to utilize that higher pH water.
Again, not by changing the pH of the body or of cells, but simply because higher pH water or we could perhaps more accurately state less acidic water, that is harder water that contains more magnesium and calcium seems to be more readily used by the cells of the body.
And therefore, it's very likely that the individuals in this study were achieving higher or more efficient levels of hydration.
So if any of this is confusing, let me be very clear.
I do not believe that we all need to drink deuterium depleted water or that we all need to drink electrolyze reduced water, nor do I necessarily believe that we all need to drink hydrogen rich water.
However, it's very clear to me that all these different forms of water are better absorbed and therefore lead to better and more efficient hydration and therefore can reduce inflammation, blood pressure and improve a number of other health metrics because of the elevated pH that all of these different purification or water treatment methods achieve.
And that elevated pH again is not changing the pH of the cells and tissues and organs of your body.
You actually don't want that rather that elevated pH is simply making the water less acidic than it would be otherwise.
So the simple takeaway is this, if your tap water contains sufficient magnesium per the values that we talked about earlier, I don't think you need to hydrogen enrich your water.
I do, however, suggest that you at least analyze your water or look at some of the professional analysis of water that you can achieve online and filter out disinfectant byproducts and fluorides, et cetera, from that magnesium or I should say sufficiently magnesium containing water.
Okay.
Put simply, if your tap water has enough magnesium, filter it, but drink it.
And I think you're doing just fine.
If, however, the levels of magnesium in your tap water are not above that value that we talked about earlier, in that case, I do think, and I can completely understand why enriching the amount of hydrogen in that water can make that water not only more palatable, right?
Give you the sensation that it's softer or smoother or more enjoyable to drink than more acidic water would be, but also that that water is going to be far more effective in being absorbed and hydrating the cells and tissues of your body, which turns out to be very important for an enormous range, perhaps every biological function within your brain and body.
So how can you hydrogen enrich your water?
That actually can be done fairly inexpensively.
I've been doing that, as I mentioned earlier, as part of an experiment in preparation for this episode, because it turns out that the water that comes out of my tap has very little

magnesium in it and very little calcium as well.
The way to create hydrogen-rich water is you can simply purchase molecular hydrogen tablets, which in reality are just magnesium tablets that dissolve in water and create a free hydrogen that can interact with the other water molecules.
Now the chemistry behind it has been substantiated, and I'll provide a link in the show note captions to a paper that gets into some fairly extensive detail about the way that having an additional hydrogen in your water can adjust the flow of electrons and the adjustment of free radicals.
But keep in mind, again, this is all through increases in the pH of your water.
And please keep in mind that you can't simply take any other or any old magnesium tablet or capsule and put it into water.
The configuration of the magnesium in these capsules and tablets is such that it allows a rapid dissolving of the tablet and the activation of the free hydrogen that can interact with the water molecules.
Again there are only a few scientific studies exploring the real biological effects of these activated hydrogen waters.
The dissolvable tablets are the far less expensive way to go than purchasing pre-packaged and sealed hydrogen water.
In fact, I don't recommend those brands because they are quite expensive and it's not clear how stable the activated or free hydrogen is in those waters.
In any case, this is certainly not something that everyone needs to do.
I mention it because I have had a good experience with it myself.
I also will mention again that I have no business or affiliation to any of these products.
I'll provide a link to a few of them in the show note captions for those of you that want to experiment.
And indeed, that's why I'm telling you this.
For those of you that want to experiment with raising the pH of your water without having to purchase what is ordinarily quite expensive, higher pH water, you can do this with these dissolvable magnesium tablets.
My experience with them has been quite good.
In fact, I plan to continue to use them once or twice a day.
This is not the sort of thing that you need to do in all the water that you drink.
I want to repeat, even if you go down this path and you find that you really like the activated hydrogen tablet approach, it is not the case that you want to put these in all of your water and you certainly don't want to put them in carbonated waters of any kind that will lead to a lot of gastric discomfort, nor do you want to put them into hot liquids of any kind.
So again, this is the sort of thing that you do once or twice, maybe three times a day and you can find out for yourself and measure subjectively whether or not you like the experience or whether or not you quote unquote feel better.
Now earlier in the episode, we were discussing structured water or this fourth phase of water.
I know a number of people out there are curious as to whether or not ingesting structured water is somehow better for us than ingesting non-structured water.
All I can say about this is that it is a very controversial thing to suggest that structured water is somehow more biologically effective or better for us than non-structured water.

There are a number of different ways that one can create structured water.
They involve some pretty extensive and expensive at home systems ranging anywhere from a couple of hundred dollars to a couple of thousand dollars or more.
To be quite direct, when one goes into the peer reviewed scientific literature, one will not find that is there is essentially no real evidence that ingesting structured water leads to any specific desired biological outcomes.
As I say that, I'm sure there are people out there who have still had tremendous experiences ingesting structured water, whether or not that's due to a placebo effect or a real effect of ingesting structured water isn't clear.
Just to give you a sense of what my stance is on things like structured water, I think that they are interesting and intriguing, but as a scientist in the absence of any quality peer review data at present, I can't really suggest that people go out and start ingesting structured water, nor that they adhere to the claims that structured water is going to be really, really good for them compared to other forms of water.
That said, I do think that there's an interesting and open space for further exploration of the biological effects of structured water, given the fact that structured water does exist, I don't think anyone debates that, and the fact that the different structures of water in this fourth phase of water, as we're calling it, has been shown to interface with solids and other aspects of liquids and can do so within organelles of cells, so different components of cells that control different functions, including mitochondria.
I think there's a potential there, whether or not there's a promise there is another question entirely, so I don't want to shut the door on structured water.
I think this is an open question that I hope there will be more data to answer those questions in the not too distant future, and meanwhile, if any of you are aware of good clinical studies exploring the biological effects of structured water in either animal models or humans, please put those references in the comments on YouTube, because I'm very curious as to how this area of biological effects of structured water is evolving and continues to evolve.
So today we discussed water, and admittedly, we went into a lot of detail about the physics and chemistry of water in its various forms, and we talked about hydration, because I think that's the main reason why many of you are interested in or concerned about water.
We also talked about contaminants in tap water, which unfortunately do exist and are very prominent in essentially all regions of the world, so please do get some information about what's coming out of your tap.
I also want to throw in one other piece of information that's really critical that I learned about when researching this episode, which is the quality of water that comes out of your tap is not just dictated by the source that it comes from, external to your home or apartment, your pipes are also important, and that filter or that little mesh that sits at the faucet head is also very important.
Most people don't pay attention to that, but it turns out that a lot of debris and contaminants can be derived from that little filter that most people just simply aren't cleaning often enough.
So here I'm not trying to tell you that the metal or the plastic that that filter is made of is a problem.
More often than not, contaminants are showing up in water because people aren't cleaning

those filters often enough, and in fact, prior to researching this episode, I didn't ever think to clean that filter.
I looked underneath my faucet and while that filter didn't look particularly filled with debris, I did find that when I took it off and I looked at the other side, there was quite a lot of debris.
So if you are going to consume tap water, you definitely want to consider the source, the pipes in your building or apartment, the ones that lead right up to your glass or jug that you would put that water into and also that mesh that that water passes through as it goes into that glass or jug.
We also talked about how much water to drink.
I hope that we finally resolve that question for those of you that have been wondering about that.
The Galpin equation is a wonderful approach to how much water to consume during exercise and by providing these other formulas of about eight ounces or 240 milliliters of water per hour for the 10 hours from waking until post-waking on average, remember it's averages, you don't have to consume them every hour on the hour and no need to be neurotic.
Hopefully you can achieve better levels of hydration, which we know can lead to reductions in blood pressure, improvements in appetite, mood and focus.
And I really think that it's the improvements in cognitive focus and physical ability, both endurance, strength and other forms of some kind of readiness in the body, readiness to perform work in the body that really are best supported by the hydration literature.
And then of course we went through the different forms of water that you hear about out there and addressed which ones are going to be beneficial or not.
And perhaps more importantly, why any of them would be beneficial, thinking about that from the perspective of biologists and the chemistry of water.
And I do hope that by arriving at this point in the episode now that you have a much better understanding of the chemistry and physics of water and the way that water can powerfully impact your biology.
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Thank you once again for joining me for today's discussion all about the science, including the chemistry, physics and biology of water and how your body utilizes water.
And last but certainly not least, thank you for your interest in science.