

**Huberman Lab #17 - How to Control Your Metabolism by Thyroid & Growth Hormone**

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## Introduction

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. 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 Four Sigmatic. Four Sigmatic is a wellness company that makes mushroom coffee. And if you're asking yourself, "Why would you want to put mushrooms in coffee?" First of all, let me tell you. These are not psychedelic mushrooms. And no. The coffee doesn't taste like mushrooms. The coffee is delicious and you don't taste mushrooms at all. I know this because I've been using Four Sigmatic coffee and been stocking it in my laboratory for several years now - long before I ever had the podcast or Four Sigmatic was a sponsor. The two kinds of mushrooms that are in Four Sigmatic coffee are lion's mane and chaga mushrooms, both of which have been shown to have a slight anxiolytic effect - to reduce anxiety. And lion's mane has also been shown in several studies to lower the symptoms of depression just slightly - although, I wouldn't consider it a treatment for depression. That's an attractive benefit - as well as have some effect at offsetting cognitive decline - albeit, slightly. The effects were real in the studies that I've found. So, if you'd like to try Four Sigmatic, you can go to [foursigmatic.com/huberman](https://foursigmatic.com/huberman). That's F-O-U-R-S-I-G-M-A-T-I-C.com/huberman. And if you do that, you'll get 40% off your order plus free shipping on mushroom coffee bundles. That's [foursigmatic.com/huberman](https://foursigmatic.com/huberman) for up to 40% off and free shipping.

Today's episode is also brought to us by Blinkist. Blinkist is an app that has thousands of non-fiction books condensed down to just 15 minutes of key takeaways that you can read or listen to. I'm a big reader and I'm a big consumer of nonfiction. And most of the time I consume books in their traditional form - like a book where you flip the pages and so forth. I also listen to full-length audio books. However, over time, we know that we forget lots of things. And even though sometimes I think I got all the critical information from a book, when I listen to Blinkist and I get the 15 minute rundown - either in audio or in written form - what I find is there are key points that oftentimes I missed. And so, it's a great way for me to both jog my memory and to bring forward ideas that I hadn't considered previously. They have thousands of nonfiction titles and some really terrific ones in the science category. For example, David Eagleman's book "Live Wired" - which came out recently - is a book I read in full-length form and I've listened to the Blinkist version of it as well. "Live Wired" is a book about neuroplasticity - the brain's ability to change in response to experience. I get so many questions and requests for books about neuroplasticity. In my opinion, "Live Wired" is the most recent, and up-to-date, and the best one to date. So, that's there. David Sinclair's book, "Lifespan". David, as many of you know - as many of you know - is a professor of genetics at Harvard Medical School. "Lifespan" is this terrific book about aging as a disease and the future and present of longevity treatments - very interesting book. As well as Matt Walker's book "Why We Sleep". Matt, of course, is a professor at UC Berkeley. And "Why We Sleep" is a terrific book about why we sleep,

the science of sleeping, and things you can do to improve your sleep. All of those are on Blinkist. But with Blinkist, you get unlimited access to their massive library of nonfiction. If you'd like to try Blinkist, right now they have a special offer just for our audience - just for Huberman Lab podcast listeners. You can go to [blinkist.com/huberman](https://blinkist.com/huberman) and you can try Blinkist free for seven days. So, that's zero cost and you'll get 25% off your new subscription. That's Blinkist - B-L-I-N-K-I-S-T.com/huberman - to get a free seven day trial and get - save 25% off when you sign up. But only if you go to [blinkist.com/huberman](https://blinkist.com/huberman).

This episode is also brought to us by Munk Pack. Munk Pack is a company that makes keto-friendly snacks that taste incredible but have just 1 gram of sugar or less. As I've said before on this podcast, I am not in ketosis. I'm not ketogenic. I don't advocate or follow any one particular diet. For me, what works is to fast in the early part of the day and to eat low-carb and keto-ish throughout the day. That's for alertness and attention so I can work, and focus, and I don't feel sluggish or brain fog. And then, at night and in the evening is when I tend to eat my carbohydrates to aid the transition to sleep. That's what works for me. Munk Pack bars are a terrific snack - whether or not you're keto all the time - whether or not you're low-carb - or even if you're not. They are absolutely delicious and I don't say that lightly. I'm not a big fan of bars, in general. Most bars to me taste like a combination of - you know - a metal bumper mixed with some cardboard, and some lawn trimmings, and some artificial sugar. Munk Pack bars - when they were sent to me, I was like, "Alright, I'll try them." I tried it. Like, "Uh-oh, this is a problem because I like them very, very much." And when I say it's a problem, it really is a problem. I actually keep the Munk Pack boxes in my basement so that I don't tear through them all at once. I'm a huge fan of the caramel sea salt flavor. It's delicious. Just talking about it makes me hungry for one. But they also have sea salt dark chocolate - peanut butter dark chocolate. They're terrific. In addition to being keto-friendly, they're also gluten-free, plant-based, non-GMO - no soy, trans fat, sugar alcohols, or artificial colors. So, all the bad stuff that you don't want. And as I mentioned before, they're keto - less than 1 gram of sugar. If you want to try Munk Pack, you can go to [munkpack.com](https://munkpack.com). That's M-U-N-K-pack.com and enter the code "huberman" at checkout and you'll get 20% off your first purchase of any Munk Pack product. That's M-U-N-K-P-A-C-K.com and enter the code "huberman" at checkout to get 20% off your purchase.

This month, we've been talking all about hormones - which are these absolutely incredible chemicals in our brain and body. They impact our entire lifespan. So, from the time that we are in the womb, they're controlling the development of our brain and our bodies. After we are born, they're still controlling the development of our brain and bodies. And I did say development and that's because, contrary to what most people think, development lasts the entire lifespan. From the time you're conceived until the time you die, you are developing. You are changing. And hormones are constantly updating and changing the different functions of your body. They have two major kinds of effects. One are immediate effects. So, they can actually bind to or - kind of - park in parking spots on cells and impact all sorts of things like the growth of cells, etc. They also can control gene expression. This is the way that hormones during puberty control body hair growth, and breast development, and growth of muscles, and limbs, and height, and all sorts of things. They

are incredible. We've talked about testosterone and estrogen. We talked about insulin, and glucagon, and some of the other things.

Today, we are going to talk about metabolism - mainly going to talk about thyroid hormone, and growth hormone, and some other related pathways. I'm going to explain to you the logic of how thyroid hormone and growth hormone work. It will become obvious why I've paired thyroid and growth hormone together in the same episode. And I will, of course, talk about tools that you can use to elevate or reduce thyroid hormone. There are cases where people want to reduce thyroid hormone. I will talk about tools that you can use to elevate growth hormone. There are rare cases where people want to reduce growth hormone. Most people are interested in increasing growth hormone. So, today is going to be rich with information - rich with actionable tools. And as always, the idea is to spell out an organizational logic so you can come away from this episode - and in fact, the entire month on hormones - really understanding - at some level - what these things we call hormones are and how they work. And that's really to arm you to encounter information going forward - whether or not it comes from me or from somebody else - a book or a course - someplace else online - to make sense of how to work with these incredible chemicals we call hormones.

### **Food Shape Myth**

Before we begin to talk about thyroid, and growth hormone, and how our metabolism works, and how to control metabolism, I want to answer a few questions that I received from you, from the audience. Every once in a while, someone will send me a quite earnest question about something they saw on the internet. And one of the things I've heard about quite a bit in the last couple of weeks is - we've been talking about hormones, and food intake, and how those interact - is this question of are certain foods particularly good for certain organs of the body and can that be predicted on the basis of the shape of those foods? So first of all, I want to acknowledge the question as a valid one because the - I see this every once in a while out there. People will say, "Well, you know - walnuts are in the shape of the brain and therefore, they are good for your brain." Or a - you know - particular fruit like the beet often looks like a heart and it's good for your heart. And I certainly invite questions of all kinds provided they are sincere questions. However, I am not aware of any science whatsoever supporting the idea that the shape of a given food - or object for that matter - is relevant to its functional role in the body in reference to biology.

Now, beets contain something that we're going to talk about today. They contain a substance called arginine which actually can control the dilation of blood vessels and arteries. So, it has some relationship to heart and heart health. Walnuts contain various fatty acids that may be - I want to underscore "may be" - beneficial for certain aspects of brain health. But there's no evidence whatsoever that the shape of the food itself is relevant. And you know, I think what's happened is that people have gone out there and found foods that contain certain substances - like carrots and vitamin A, or walnuts and particular fatty acids, or beets and arginine - and they've selected the foods that happen to be in the shape of the thing - the organ - that the particular substance like vitamin A, or fatty acids, and so forth might benefit or support. But of course, there are many, many other sources of these nutrients that don't come from walnuts, or from beets, or from carrots. And

so, I guess the short way to put it is that the idea that the shape of some - some food is an indication of whether or not that food would be healthy for a particular organ in the body is absolutely unfounded. I don't know of any evidence for it. And I'm not out to quash anybody's great love of these foods. I enjoy all the foods I just described. But the shape of things in the physical universe bears very little - if any - relevance to the nutrients that it - that it contains and therefore, the organs that it supports. So, thank you for your question. But if you see that out there, I would - I don't even think you need to tell the person who's putting that information out into the world. I would just - you know - back away slowly.

### **Correction - Stevia**

One other thing before we move into today's material. Last episode, I talked about the problems with emulsifiers in highly processed foods and the way that they can strip the mucosal lining of the gut and they can limit the signaling of hormones like CCK that can signal to the brain satiety - the signal to stop eating. And then, we got into a discussion about artificial sweeteners. And I threw out Stevia as an artificial sweetener and several people reached out to correct me - that Stevia is not an artificial sweetener. It is a noncaloric sweetener. And you are correct. I lumped artificial and noncaloric sweeteners together. And thanks to many of you that also sent me some references, it does not appear that Stevia can negatively impact the gut microbiome. It does seem unique among noncaloric sweeteners. There are probably others out there.

The other thing that we discussed is how Stevia can lead to slight increases in blood glucose, but can also improve insulin management just slightly - probably cancels to zero in terms of its impact on blood glucose - provided it's not at concentrations that are super, super sweet. Ingestion of anything that's very sweet - whether or not it contains calories or not - artificial or not - will create an insulin response. In fact, just walking past a bakery and smelling delicious baked goods can increase your insulin secretion. And so, I just want to point that out. Thank you for the information and the references that you found. Please send additional ones if you do find them. And I appreciate that you allow me to make corrections. Every once in a while, I misspeak here and the opportunity to make corrections keeps us all on the same page. And please do keep any feedback that you have about particular things I cover here coming my way.

### **Metabolism**

There is so much interest in metabolism. We hear about having a high or a low metabolism. There are some people out there who would like to reduce their metabolism. They simply can't eat enough to maintain their weight. Most people, however, struggle with the opposite issue. They struggle to maintain a healthy weight and/or their metabolism is too low. Now, there are a variety of reasons why metabolism can be low. Today, we are going to talk about two hormones: thyroid hormone - and its related pathways - and growth hormone - and its related pathways - which arguably are the two hormones and two systems in the body that are most significant for setting your overall level of metabolism.

Before we dive into those, I just want to cover a little bit of what metabolism is. And I want to talk about which organs in your body use the most energy. So, metabolism is the consumption of energy - not necessarily eating - but it's the use of energy in the cells of the body for growth of tissues, for repair of tissues, and also just for day-to-day maintenance of function. A good example of maintenance of function would be your brain. Most of your metabolic needs - your so - so-called basal or resting metabolic needs - are for your brain - for thinking. If you were to just sit in a bed all day and do nothing but think, that consumes about 75% of your metabolic needs. Now, there's also moving around. If you have a job that requires a lot of heavy labor or lifting things - or you're a new parent, and you're carrying kids around, and you're going up and down the stairs, or back and forth to - to the refrigerator - for formula, etc. Well, then you're burning more energy - burning more calories. But even if you are very physically active, unless you're an ultramarathoner or a marathoner, chances are that 75% of your metabolic needs are coming just from your brain. And that's because neurons consume a lot of energy. Neurons, of course, are just the nerve cells of your brain. So, these two hormones - thyroid hormone and growth hormone - we think of as related to metabolism of things in the body - keeping body fat low, and keeping muscles strong and tendons strong, and repairing themselves, etc. But they are also key for brain function - for the ability to maintain cognitive function throughout the lifespan. So, the big theme I'd like to introduce is that metabolism isn't just about losing weight. But having a high metabolism - provided it's not too high - is great. It means that you will have more lean tissue, more bone and muscle, and less adipose tissue - fat. And we know that that's healthy. How much fat? And how much muscle? Well, that varies and the numbers on this are always shifting. But in general, muscle and its related tissues burns more energy than does adipose tissue or fat. And the water in your body doesn't consume any energy. So, metabolism can be increased simply by adding muscle to your body and reducing fat or adjusting the ratio of the two. But regardless, even if you're not interested in changing body composition, these two hormones - thyroid hormone and growth hormone - are super important for metabolism of all kinds - including tissue repair after injury - including maintaining cognitive function, and well-being, and the ability to think clearly as you age - offsetting dementia and so forth.

### **Releasing Hormones From Brain / Stimulating Hormones From Pituitary**

So, the big theme here really includes the previous episodes. You don't have to have seen those episodes. But for the last three episodes - and today as well - we've been talking about hormones - these substances that are released from one location in the body that go and act at other locations in the body. I'm going to tell you how that works for thyroid and growth hormone, but now that you've heard about testosterone and estrogen - and you're going to hear about thyroid and growth hormone - I want you to realize that there's a repeating logic. First of all, there are neurons in your brain in an area called the hypothalamus - which just means it's below the thalamus. "Hypo" - it sits at the base of your brain in the front. It's part of the forebrain. So, it's more or less above the roof of your mouth - maybe about a centimeter or so - and then, about a centimeter forward in most people.

And neurons in the hypothalamus release hormones that are called releasing hormones. So, we've talked in previous episodes about, for instance, gonadotropin-releasing hormone. So, those are little neurons that then signal another brain area called the pituitary to release other hormones. Today, we're going to see this again. In the brain, you have neurons that release thyrotropin or thyroid-releasing hormone. You also have growth-hormone-releasing hormones. So, anytime you hear "releasing", chances are those are neurons that are in your brain and they extend little wires - we call axons - into your pituitary. And the pituitary releases a bunch of hormones into the bloodstream. And the pituitary releases things that most often have the name of "stimulating hormone" because they stimulate organs. So, in keeping with the theme of thyroid hormone, you have thyroid-releasing hormone in the brain - tells the pituitary to release thyroid-stimulating hormone. And then, the thyroid - which we'll talk about in a moment - releases thyroid hormones. In the testosterone and estrogen episode, we talked about how you have gonadotropin-releasing hormone. There's the "releasing" again - up in the brain. Remember, releasing hormone comes from the brain. Then, you had things like luteinizing hormone and follicle-stimulating hormone - which were in the pituitary - and those traveled to the ovaries or the testes and acted on those tissues, okay? So, please try and embed this logic. If you hear the word "releasing hormone", it's coming from the brain. And that makes it actionable in certain ways that we'll return to later. In addition, the pituitary is - is letting go of all these hormones into the bloodstream that are stimulating different tissues. So for thyroid, it's thyroid-stimulating hormone. And then, it goes to the thyroid.

### **Thyroid Organ**

And the thyroid is a little butterfly-shaped gland that's right around the Adam's apple. If you want to see yours - not directly because it's got skin over it - what you would do is you'd take a sip of water, you'd look in the mirror, and you'd swallow. And the thing that moves up and down, that is your thyroid. Now, some people call it your Adam's apple because it sits right near this protrusion in the trachea - which is the Adam's apple. No matter - whether or not you're male/female - or regardless of what your chromosomal background is - everyone has an Adam's apple. It tends to be more pronounced in people that got a surge of testosterone early in development because it has a testosterone-sensitivity to it and that actually controls the timbre - the so-called deepness of the voice. So, the thyroid gland sits right there and it's got four little bumps behind it called the parathyroid gland.

### **Thyroid Hormone - T3 / T4**

And it releases two hormones into the blood to stimulate different tissues and their metabolism. And those hormones are called T4 and T3. So, if this is already sounding like a lot of information, it's really easy. I promise. Releasing hormone comes from the brain. Stimulating hormone comes from the pituitary. And in this case, we're talking about the thyroid binding up that stimulating hormone and saying, "Oh, I need to release something." And it releases T4 and T3. And guess what? You can basically forget about T4. T4 - it's not completely inactive. It has some roles, but T3 is the one that's more or less active. Now, what does thyroid hormone do? A lot of people think, "Oh, thyroid. It's like metabolism. And people who are hypothyroidal have bulging eyes and are real thin. And people who have hypothyroid are overweight and they have like - their eyes are like - are - you know -

half-closed or something." And indeed, thyroid hormone controls a lot of the features of the face, and the eyes, and it can control amounts of adipose tissue, and so forth. But the main role of thyroid hormone - of T3 - is to promote metabolism. And that doesn't just mean the consumption of energy. It means the utilization of energy - including the buildup of tissues. So, it acts on all sorts of target tissues in the body. It acts on muscle. It acts on the liver. It acts on the cartilage. It acts on the bone. And it's not just involved in using energy. It's also converting energy. I do realize I said that twice. It's involved in taking fats, and breaking them down into fatty acids, and converting those into ATP - which is an important thing for cells to use energy. It's also involved in taking sugars and turning those into energy. And yes, it goes to adipose tissue - to fat. We have different kinds of fat that we'll talk about today, but it goes to white fat and it liberates - or helps liberate - some of the fats from those fat cells and use them for energy. And this is why higher thyroid is associated with leaner bodies. Lower thyroid is associated with less lean bodies.

### **Iodine, L-Tyrosine & Selenium: The Trio Essential For Thyroid Function**

So, one thing that's absolutely key and is actionable - we're right there already in discussing tools - is iodine. Iodine comes from things in the ocean, right? And here are a couple interesting facts about iodine. And then, we'll talk about whether or not you should be supplementing iodine or not. First of all, iodine is most common in sea salt, in kelp, and in seaweed. And most people can get enough iodine from the food they eat and/or the table salt they consume. Almost all table salt from all over the world - regardless of where you are - contains iodine. The thyroid needs iodine in order to produce thyroid hormone. And you need sufficient levels of thyroid hormone - not too much, but you need it. So, chances are you are getting enough iodine - although, you might not - especially those of you following a particularly quote-unquote "clean diet" might not be getting enough iodine. Here's the deal with iodine. Iodine combines with an amino acid that we've talked about before called L-tyrosine. L-tyrosine comes from meat, from nuts - there are some plant-based sources as well. It is the precursor to dopamine. But in the thyroid, iodine combines - or works with - L-tyrosine to produce T3 and T4 - the thyroid hormones. So, you absolutely need sufficient iodine. You need sufficient L-tyrosine. And then, you also need something else, which is called selenium, and we'll talk about selenium in a moment.

So, there's a condition that shows up in little pockets in the world. It's not super common, but - meaning it's not very widespread - but in certain areas that are far away from the ocean - at one point this was historically in the Midwestern states of the United States, in some mountain regions of other countries, in some areas of Africa that were far from the ocean - people would get extremely swollen bulges in their necks. And this was called goiter. And the reason they were getting those swollen bulges is because the thyroid itself was hypertrophying. It was growing in an attempt to churn out more thyroid and because it was getting a lot of stimulating hormone from the pituitary. But - and I don't want to go too far off track here - but as you recall, the brain and the pituitary are paying attention, in a cellular sense, to the levels of hormones in the blood. And when those hormones get too high, they shut off the stimulating hormone. They shut down the signal to make more - kind of like a thermostat. When the levels are too low - like there's not enough testosterone in the bloodstream or there's not enough estrogen - the brain will continue to push out



the signal to make more. Similarly, if there's not enough thyroid circulating or there's not enough iodine to make thyroid - therefore, not enough thyroid hormone circulating - the thyroid gland itself is not getting shut down. There's tons of stimulating hormone and releasing hormone coming from the brain - like, "Release! Release! Release!" And there's no way they can make thyroid hormone. And so, the gland just gets bigger, and bigger, and bigger. And so, people get goiter. This is one of the reasons why table salt has iodine in it - although, there are other foods that have iodine in it as well.

So, how much iodine do you need? Well, you don't need a whole lot. Some people who are hypothyroidal might - and I want to emphasize "might". You absolutely should talk to your doctor. This is a serious matter. Anytime you're talking about hormones or manipulating levels of thyroid, you absolutely want to talk to your doctor. Some people benefit from supplementing iodine. It is contained in most salts. It's in Himalayan salt - not always, but often. I know these days there's a lot of excitement about pink salts, and sea salts, and - you know - the - kind of - artisan salt thing has - kind of - taken off in the foodie land - which is great. Some of them are - are actually quite tasty. You can just take it directly if you like the taste of salt. But iodine can be supplemented through things like kelp, and seaweed, and kelp tablets. Now, if you are hyperthyroidal - you make too much thyroid - that actually can be a problem. So really, the best way to figure this out is to get your blood levels tested of thyroid hormone. But there's so much iodine in the ocean that, believe it or not, people that live near the coast can actually just absorb it through the air just by breathing ocean air. So, that gives you a sense of just how little iodine you actually need to consume in food or in salt. So, if you're within a few miles of the ocean or you visit the ocean from time to time, you're probably getting plenty.

It does have to come together, as I mentioned, with L-tyrosine. And this is why foods that contain L-tyrosine - and provided that you have sufficient iodine in your diet - and if you have sufficient selenium in your diet - does serve to increase your metabolism. And that is, again, is for the growth and repair of tissues. And that's really important. It's not just about keeping your metabolism high so that you can be on the leaner side of things or just your body weight - excuse me, your body composition ratio - is the way you like - repair of injuries, repair of brain tissue, clearance of any damage from neurons, clearance of any damage to the body - is also going to depend on thyroid. Again, metabolism being this - kind of - rate of fuel consumption and use in the body, generally - not just about body mass indexes and things of that sort.

### **Tool - Selenium**

So, let's talk about selenium because it's really important. And even though most people are getting a lot of sufficient iodine - and most people are probably getting enough L-tyrosine - I'm guessing most people may not be getting enough selenium if their goal is to increase thyroid hormone - at least, that's what the - the literature says. Without going into the biochemistry, selenium is important in order for thyroid hormone to be made because of the way that it allows L-tyrosine and iodine to interact. And the thing is most people aren't getting enough selenium because they don't eat foods that are high in selenium. Now, the - how much selenium you need will depend on where

you live. It actually varies country by country. Some countries I found say that you should get 100 micrograms. Some say 200. Some say 155. The average was about 155 micrograms - the countries I looked at. People who are trying to increase thyroid levels might want to consume more selenium. And if you consume a vitamin, of course, you want to make sure - if it has selenium, that you're not overdoing it by consuming a lot of selenium-rich foods either. But nonetheless, I think it's fair to say that most people probably could do well by ingesting slightly more selenium than they currently are - although, of course, always talk to your doctor.

Brazil nuts are the heavyweight champion of foods to get selenium from. It has very high concentrations of selenium. In just 6 or 8 Brazil nuts, contain something like 550 micrograms of selenium. It's also present in fish. So, certain fish like yellowfin tuna - although, nowadays whenever I mention tuna or shellfish - which is the other rich source of selenium - people will tell me immediately there - there are all sorts of issues around farm - not farm - mercury, etc. So, I've never particularly liked eating fish because of the way it tastes. So, that's why I avoid it. But for those of you that like it, I'm sure you're much more skilled in knowing which fish to buy and which fish not to buy. Ham - of all things - contains a lot of selenium. For whatever reason, pork does. I'm not a big consumer of pork. Beef has some selenium. But what's interesting - if you look at the sources - pork, beef, turkey, chicken, cottage cheese, eggs, brown rice - they - what you want to understand is that Brazil nuts - 6 to 8 Brazil nuts has 550 micrograms of selenium and all the other foods I mentioned - at much greater portion size than equivalent to 6 to 8 Brazil nuts - either by volume or by calories - they - they have something like 30 to 50 micrograms of selenium. So, if you're not eating Brazil nuts - I'm guessing most people aren't - then - and you're not eating a lot of animal based foods - which I know many of you aren't - then you're probably not getting enough selenium. And again, you can have these levels measured or you can just check what you're consuming and figure out whether or not you're meeting the ration that you need in order to get healthy levels of thyroid. It is present in things like mushrooms. But again, in a bowl of mushrooms - you know - the - what is the equivalent to a bowl of mushrooms - 12 micrograms of selenium. And if the daily ration is something in the 100 to 200 range - again, look it up for the area you are - you can see really quickly why even though things like mushrooms, and spinach, and milk, and yogurt, and lentils, and cashews - so now, we're into the vegetarian segment of the list that I constructed - you're probably not getting enough selenium. So, it's kind of an interesting thing. If you're an experimenter - you - and you get the clearance from your doctor, you could try increasing your selenium levels and see how that impacts your metabolism. Again, Brazil nuts are probably going to be the most direct way to get sufficient selenium levels. But because levels are so high in Brazil nuts, it also means that you could overdo it as well.

I'm not really aware of what the consequences are of getting too much selenium - although, you can get too much of anything - and I'm guessing those consequences aren't good. I also want to mention that for children, the daily requirements of selenium are much lower - as low as - you know - 30 or 40 micrograms for kids 14 years or younger. And in some areas - I really want to underscore this - the amount of selenium that's recommended daily is as low as 55 micrograms. So, it's not that you should be shooting for thousands or even hundreds - you know - high levels of hundreds of - of

micrograms of selenium. And again, that's micrograms, not milligrams. So again, look into what you need. But if you're somebody who's interested in keeping thyroid function healthy and productive, then you certainly want to make sure you're getting enough iodine, you're getting enough selenium, and you're getting enough L-tyrosine. And it's interesting when you start looking at the various foods - especially highly processed foods - then you start to realize that perhaps many people, maybe you, are not.

### **Benefits of Selenium - Reduction in Preeclampsia / Prostate Cancer / Acne**

Not incidentally, selenium has some other effects on health that can be quite positive. And even though these don't relate to thyroid or growth hormone function specifically, I think you might want to know about them - given that we're on the topic of selenium. The first is that there are three studies - all of which showed very high efficacy for reducing the risk of something called preeclampsia - excuse me, preeclampsia. Preeclampsia is seizures that are related to blood pressure issues during or - or around the delivery of a new baby. And it - actually, it's a rare-ish condition. But it actually can be quite deadly. And so, the fact that selenium is important for offsetting preeclampsia risk is interesting. I don't know the exact mechanism. And I'm guessing there are only a few of you out there that are either pregnant or thinking of - of conceiving soon, but that's worth noting. Obviously, anything related to pregnancy or lactation, especially - talk to your doctor. I'm guessing that selenium is probably in a lot of prenatal formulas. But that's one clear benefit of having sufficient selenium.

The other is a reduced prostate cancer risk. There's a study showing that having sufficient selenium can reduce prostate cancer risk. And there is some evidence that if you consume foods from areas with soil that's low in selenium, that can be a problem. And last episode, we talked about all these issues related to soil quality - things that are making their way into food. They're disrupting hormones and so forth. But having sufficient selenium from food could offset the low content in any soil. And so, that apparently can reduce prostate cancer risk. It's a minor effect, but it's a - a statistically significant one.

And the other one is a reduction in acne - which is interesting. I - I'm guessing that that probably has to do with the thyroid hormone pathway because of the way thyroid hormone can impact the liver. And it turns out that the liver and various biochemical reactions in the liver can impact acne. And that's probably an episode all unto itself, but those are just some additional benefits of getting sufficient selenium.

Okay, so we're already deep into tools related to making sure that you have sufficient selenium, iodine, and L-tyrosine in order to make enough thyroid hormones that can support your metabolic processes in your liver, your muscles, your tendons - for whatever purpose - keeping your metabolism high for body composition reasons or for healing - for keeping your brain working well.

## **Clean Diets**

Earlier I mentioned there are people who are following very clean diets. So, these are people that consume no processed foods - you know - any starch they might eat is going to be maybe a rice or a grain - or any - any protein they might consume is going to be either from - let's hope from humanely raised animal sources - or maybe they're pure plant-based. Believe it or not, those folks are actually very susceptible to low iodine because it turns out that diets that are very meat-rich and don't have many vegetables - as well as diets that are very vegetable-rich but don't have many meats or salts - are at risk of lowering thyroid hormone by way of the iodine pathway and other pathways. And so, let me try and simplify this for you. Chances are if people are doing the all-meat diet, they're not sprinkling - they're not wrapping those steaks in seaweed. And they may or may not be supplementing with iodine. Chances are they're probably consuming iodine salt, but their - their requirements go up if they're not consuming vegetables. People who are consuming vegetables - it's kind of interesting, we always hear that we should have our cruciferous vegetables. And those are so important, but there are actually substances - compounds - within high-quality cruciferous vegetables that can interfere with thyroid hormone function. So, if you're eating a lot of that stuff - a lot of cabbages and the - you know - just look up your other - I think broccoli is a cruciferous vegetable - and I won't read off the whole list. You could just put into the internet. But if you're - you know - we're always told to eat a lot of the dark leafy green stuff. Well, unless that dark leafy green stuff is kelp or seaweed, chances are that we're not getting enough iodine - unless we're adding salt to our food. And chances are that we may be lowering the total amount of thyroid that we're making - as well as the fact that in plant-rich diets, it's hard to get enough L-tyrosine. And I don't want - you know - I'm not here to inflame any of the - the vegans or the carnivore folks. I don't take a stance either way on any of that. I'm just learning - trying to report the science. The point I want to make is your health is important. So, if you are purely plant-based and you're eating a lot of cruciferous vegetables, make sure you're getting enough iodine. It does seem like the cruciferous vegetables can increase the need for further iodine. And same thing if you're purely - and you're on this all-meat diet or your keto and you're not ingesting many vegetables. So, I always thought that the cleaner the diet the better. But it turns - and probably that's true from the standpoint of - you know - hormone regulation - you know - estrogen, and testosterone, and other - and other hormones. The highly processed foods really are terrible. There's so much evidence for that. The phthalates in plastics, and the processed foods, and the emulsifiers - all the stuff we talked about previous episode. But it does seem to be that people that are not getting enough iodine for whatever reason really need to check out whether or not their iodine levels need to be increased because of the fact that they're consuming so many plants or so many meats - and not - and in some cases, plants that actually lower thyroid hormone.

## **Benefits of Iodine - Reduction in C-Reactive Protein (CRP) / IL-6**

And not to beat a dead horse - or cabbage - but there are a number of things that iodine can do that are positive - that are sort of - they're related to thyroid - not directly. They're - kind of - offshoots of the thyroid pathway - on their downstream of it, we would say - in terms of how they impact metabolic function. One of those is to reduce something called c-reactive protein. Some of you may have heard of CRP or c-reactive protein. C-reactive protein is something that you want to keep

at modestly low levels. It's associated with inflammation and various forms of heart disease and even eye disease - macular degeneration. So, it does appear that iodine supplementation or getting sufficient iodine from food - either works - is associated with reduced levels of c-reactive protein in the blood and an anti-inflammatory effect.

And the anti-inflammatory effect brings us back to our old friend, interleukin-6. Remember, they're these inflammatory cytokines. They have many, many names because there are many, many of them. Interleukin-10 is the one that is anti-inflammatory. Interleukin-6 is the one that is inflammatory. Anytime you see "IL-6", that usually means that there's an inflammatory response. There's a wound. There's inflammation of the brain. Somebody is either sleep deprived, or had a brain injury, or they're dealing with some sort of infection. IL-6 is kind of a catch-all for inflammation. And it does appear that iodine supplementation can reduce circulating IL-6 associated with inflammation. So in that sense, iodine can have an anti-inflammatory effect.

By now, it should be abundantly clear. If you care about thyroid hormone - if you care about the pathways that it impacts - like having a high level of metabolism - which, I guess, if for no other reason is attractive because then, you can eat more and still maintain a - a healthy body composition - but also for brain health, cognitive function, tissue repair - all that stuff - keeping c-reactive protein low - keeping IL-6 low. Make sure you're getting enough iodine, selenium, and L-tyrosine.

### **How Increased Thyroid Increases Metabolism**

If you're curious how thyroid actually increases metabolism, allows you to eat more, etc. - it relates to something we covered last issue - which is glucose. Remember, when you eat something, blood sugar goes up. Insulin is secreted from the pancreas. And it makes sure that blood glucose doesn't go too high, which can damage tissues - or too low, which can make you hypoglycemic. Thyroid increases glucose uptake by various tissues - in particular, muscle and bone. It actually can increase bone mineral density, which is a really good thing as you get older. When I say older, I mean - basically, 30 and older. You - the reason you can recover more quickly from injuries if you have a healthy thyroid and healthy thyroid pathways, is because you can - can consume energy. That energy is diverted toward bone repair, and muscle repair, and cartilage repair. And so, the way it does this, again, is by increasing ATP. But the whole idea here is that iodine, selenium, L-tyrosine allow thyroid to be at healthy levels so that thyroid then can take glucose in the blood and divert it to tissues for it to be used - in particular, your brain.

### **What To Eat To Support Your Brain**

And that's why these things that we're talking about supplementing or getting from food can actually improve or support brain function. People are always asking me, "What is the food that I should eat for my brain? Like, are blueberries good for your brain?" - or they do ask me, "Are walnuts good for your brain because it looks like a brain?" We talked about that earlier. The fact of the matter is - there - what you need are nutrients that support hormones and biological pathways that support the brain. That's the way to think about it. And I realize when people ask, "What should I eat

to support my brain?" That's basically what they're asking in short form. So, keeping your thyroid hormone healthy - at healthy levels, that is - is going to be terrific for your brain because 75% of your metabolism is from your brain. The ability of your brain to use glucose - or ketones, for that matter - is going to be aided by having healthy thyroid. So, do the things - take the things - eat the things - that are going to allow you to have healthy levels of thyroid hormone.

### **Hyperthyroidism / Hypothyroidism**

I'm sure a number of you are out there wondering, "Do I have healthy levels of thyroid hormone?" Those can be measured from the blood. There are some telltale signs of having really high thyroid or really low thyroid. And I could start listing those off. They're easy to find online as well. Things like - you know - bulging eyes, inability to maintain weight, shaky, anxiety - that's kind of hyperthyroidal - thinning of hair - this kind of thing. I don't want to get into diagnosing hypothyroidism and hyperthyroidism. It's just impossible because they're - you're there and I'm here - and we're - kind of - shouting back and forth through a tunnel of video and comments. If you're concerned about having excessively high or excessively low levels of thyroid hormone - absolutely, look up what the symptoms are. Talk to your physician. And there are a number of good treatments. I didn't talk about prescription drugs that can improve symptoms related to hypo or hyperthyroid. Of course, they have synthesized thyroid. So, if you don't make enough thyroid, you can take thyroid. It's by prescription. If you take - have too much thyroid, sometimes they'll take out the thyroid gland or they can administer drugs that will either block receptors or will interfere with some of the pathways from the brain to the pituitary or from the pituitary to the thyroid in order to adjust thyroid hormone that way. So, there are the - the big guns in terms of the treatments for different thyroid disorders. But we're not talking about thyroid disorders. We're talking about how to get and maintain thyroid levels in healthy ranges and some straightforward ways to do that through diet and supplementation.

### **Menstruation / Ketogenic Diet**

There's also a lot of evidence that for people who menstruate, levels of thyroid hormone can fluctuate dramatically across the menstrual cycle. So, that's really going to be a process of experimentation. I don't know that you could necessarily - you could, in theory, take blood at different phases of your cycle and figure out whether or not your thyroid hormone is excessively high or low at different phases of the cycle. That's going to be pretty tough to do. If you have an endocrinologist that's willing to do that with you, terrific. I think most people are going to have to figure out how supplementing the sorts of things that we talked about before or getting them from foods relates to different aspects of their cycle. In general, the first half of the cycle - before ovulation - people create carbohydrates and sweets more - related to the - and that makes total sense based on the biology of the menstrual cycle. Thyroid hormone is going to go up as you - as anyone - male or female - menstruating or not - increases more starchy carbohydrates.

This is interesting because ketogenic diets have been shown to slightly lower thyroid levels. And that makes sense because in ketogenic diets, blood glucose levels are very low and thyroid hormone is secreted, in large part, in proportion to how much glucose is in the bloodstream and

how much that glucose - glucose, excuse me - needs to be regulated. So, I'm not trying to demonize the ketogenic diet. I think it definitely has its place. There are 22 studies now showing that it can dramatically reduce blood glucose and about a third of those show that thyroid hormone levels are slightly reduced - sometimes significantly, if not more - in the ketogenic diet. That may explain - I want to highlight "may" - explain the fact that when people go back to a more traditional diet - if they've been on a ketogenic diet for a long time, that oftentimes they will gain weight very quickly as they bring carbohydrates back into their diet. Some people are cycling between ketogenic and non-ketogenic every 3-4 days - so-called cyclic ketogenic diet. Some people are staying ketogenic for long periods of time. Some people 6 days on, 1 day off. So, it's a huge variation there. The point is that carbohydrates - starchy carbohydrates, in particular - support the healthy production of T3 and T4. And so, if you're very low-carbohydrate, you're going to have a reduction in T3 and T4. And so, if you're going to bring carbohydrates back into your diet, then you might want to do it more gradually. And for those of you that menstruate and are craving carbohydrates in the early part of the cycle, that is actually associated with having a healthy cycle. If any of you have had a healthy cycle on a ketogenic diet, that would be interesting. Maybe let me know through the comments or - or point me in the direction of some research, if you're aware of it.

## **Recap**

So, as you can start to see, there's this really beautiful interplay between the different hormones - between insulin and glucose - between estrogen and thyroid - between thyroid and blood glucose and the ketogenic diet. It all starts to fit together in ways that make a lot of sense once you understand just - kind of - the core elements of what the hormones are and the variety of tissues that they work on. The simple version of this is: if you haven't had a carbohydrate for a year, then your T3/T4 levels are going to be pretty low. And I'm sure there's some ketonistas out there that are going to say, "Wait, no. Thyroid hormone levels go up with keto." That might be true for other reasons - indirect reasons related to hormone pathways that are - you know - cascade from being in ketosis for long periods of time - great. But for most people that don't consume any carbohydrate, T3/T4 are going to go down and when they start to consume foods that require thyroid metabolism in order to work with - to metabolize - then weight gain can sometimes happen more quickly. So, it's just something to consider and it's something to work with carefully if you're going to be cyclic ketogenic - long-term ketogenic. And if you're not ketogenic, and you're consuming carbohydrates, and the three things that we talked about earlier - selenium, tyrosine, and iodine - chances are - unless there's an underlying condition there, that your levels of thyroid are going to be in healthy range.

## **Growth Hormone**

Next, we're going to talk about growth hormone. Growth hormone has received a ton of attention in the last 20 years. I actually remember when it was first sequenced. This was a huge deal. There was a huge patent drama. I won't mention the universities or the people involved. There were companies, and monster patents, and payouts, and it was really interesting. You can look that up online if you're interested in some of the scientific history. Growth hormone is a pretty straightforward one for you to understand now because it follows the exact same logic as thyroid

hormone. In fact, their functions are so closely overlapping on the - you know - when we first look at the face of it - that you're probably going to think, "Why do you have these two systems?" So, just very briefly, growth-hormone-releasing hormone - so remember, "releasing" means it comes from the brain - comes from the brain and tells the pituitary to release growth hormone. And then, growth hormone is released into the bloodstream where it goes and acts on a ton of tissues - muscle, ligaments, bone, fat, etc. - to increase metabolism. It sounds just like thyroid hormone. And they do work in parallel and that's why we've lumped them together in the same episode. They increase metabolism and repair and growth of tissues.

A conversation about growth hormone would be incomplete if we didn't talk about the - kind of - extremes. There are certain people who are born that don't make enough growth hormone and they end up very short in stature. There are certain people who make a ton of growth hormone and they end up very, very large. They tend to have very large appendages. They have something called acromegaly. It's - kind of - like a ridging of the - of the forehead. It's actually a bone ridge. They are giant. And it used to be called gigantism. And most people, of course, are in a range of height and appendage length that doesn't imply that there's a growth hormone disruption there.

Growth hormone received a lot of attention after it was sequenced because that meant the opportunity to inject growth hormone and replace growth hormone that was lost. And there were actually a lot of cases of people taking their kids and trying to get them to be taller for whatever reason by injecting growth hormone. Today, we're going to talk about the things that anyone can do to increase growth hormone. And there are reasons why certain people would want to do that. People who overproduce growth hormone certainly would not want to do that. People who underproduce it would - would probably want to do that. People that make "normal" quote-unquote levels of growth hormone might want to do that as they age because during puberty and development, the pituitary is churning out tons of growth hormone. It's responsible for the growth - not surprising - of the body and all its features - height just being one of those. And so, as we age, we make less growth hormone. And that is one of the reasons why we recover more slowly from injuries. It's one of the reasons why we accumulate body fat. And it's one of the reasons why our metabolism slows. And so, growth hormone replacement therapy has been tremendously popular in the last 20 years - which is not to say it doesn't carry its problems. It does.

Here's one of the major problems with injecting growth hormone. Not saying people shouldn't do this if the doctor has approved it or it's in keeping with their particular life goals. But growth hormone - if it's in levels that are too high - will cause growth of all tissues. So, not just muscle - not just reduction in - of - in body fat - by metabolizing - you know - by - by allowing fatty acids to be pulled out of storage and used for ATP. But it will also cause increase in growth of the heart, and the lungs, and the liver, and the spleen. And so, this is the concern with abuse of growth hormone. So, we're not going to be talking about abuse of growth hormone.

We will, however, talk about tools that anyone can use to increase levels of growth hormone. Some of them are behavioral. Some of them are supplement-based. And some of them interact with



behaviors and supplements. And what's cool about the discussion about growth hormone is that the tools that exist out there to increase growth hormone are very actionable. Most people can do these without the need for any equipment or even any supplement - although, there are some supplement-related themes for tools for growth hormone increase. And also, the increases that one can get in growth hormone are substantial. So, normally, when you talk about the difference between taking something as an exogenous substance - like testosterone or estrogen - versus using supplements or behaviors to increase them - you're talking about tenfold differences from - you know - administering the prescription compound. In terms of growth hormone, there are things that can increase growth hormone three, four, five hundred percent or more. And even though that's a short-lived increase, they can have very powerful effects on metabolism and on repair of tissues. So, let's talk about those.

### **Tool - Slow-Wave Sleep / Avoid Eating 2 Hours Before Sleep**

Okay, let's go step-by-step in terms of the things that anyone - perhaps everyone - should be doing in order to maintain healthy growth hormone levels or increase growth hormone levels. Unless you have overproduction of growth hormone, chances are these things are going to benefit you. However, as always, I want to emphasize talk to a doctor before you do anything - including removing any treatments. So, anything you would add or take away - that's a responsibility of you and your health care provider, okay? I don't just say that to protect me. I say that to protect you. First of all, growth hormone is released every night when you go to sleep. And it's released in the early part of sleep during so-called slow-wave sleep. So, the two conditions that have to be met in order for growth hormone to be secreted regularly for tissue repair, etc. - are you need to get into slow-wave sleep - the so-called deep sleep - and you need blood insulin and glucose to be relatively low. So, eating within two hours of sleep - excuse me, eating within two hours of going to sleep - is going to suppress growth hormone release. That's very clear. However, some people are going to have problems falling asleep if they are too hungry. So, you have to work with that and decide what you're going to eat and when you're going to eat that thing so that you're not so hungry that you're having trouble falling asleep. The episodes on sleep that were covered in episodes 2, 3, and 4 of the Huberman Lab podcasts. has, I believe, more tools there than you could ever want or make use of in terms of how to optimize sleep. So, you can refer to those if you like. So, don't eat too close to sleep. And then, get into slow-wave sleep. And as I talked about in one of those earlier episodes - the first half of the night, slow-wave sleep and deep sleep predominate. The second half of the night, it's another kind of sleep - we call REM sleep.

### **Delta-Wave Activity Triggers Growth Hormone Release**

So, what is special about this early phase of sleep? This is how you should be thinking if you listen to this podcast. You should be thinking, "Okay, I hear that something is important. It's related. It's in the pathway." But mechanistically, when we say, "Get into slow-wave sleep. Get into deep sleep. That's when growth hormone is secreted." The question you should be asking yourselves - as scientists - of yourselves is: Wait, why slow-wave sleep? What, in particular, about slow-wave deep sleep allows the pituitary to release growth hormone? Like, what - what is it? Because if you can understand that - if you can understand a little bit of mechanism, there are actually ways that you

can increase the amount of growth hormone that you release - both in sleep and out of sleep. So, the answer is: It's a delta-wave activity in the brain. Delta waves are these big, giant waves of activity in the brain that correlate with slow-wave sleep - as opposed to faster waves of activity that associate with rapid eye movement sleep. So, slow-wave sleep and the delta activity actually triggers the neurons in the brain - the releasing hormone, right? Growth-hormone-releasing hormone neurons - to - to signal to the pituitary.

Now, how do I know this is true? And what can you do with this? Well, we know this is true because researchers have taken people and sleep deprived them. And they just asked: Well, is it just one period of time every 24 hours? And then, the pituitary releases growth hormone? If that were the case, that would say that growth hormone is just released in a so-called circadian-dependent way. Every 24 hours is just a pulse of it. But no. It's always relating to slow-wave deep sleep and delta waves. And this is cool because what it means is that even if you're not measuring your brainwaves during sleep - which most of you probably are not - you might be measuring slow-wave sleep or deep sleep using a - a device like a WHOOP or an Oura. And even if you're not, what this means is that during the day, there's the potential to also increase growth hormone release if you can get the brain into the so-called delta waves. And it turns out there are things you can do in waking as well to increase growth hormone release. So, we're going to talk about those next.

But as a tool - and to just really make sure that we put brackets around this - try and have blood glucose not too high. So, if you do need to eat close to bed, you wouldn't want to eat - eat anything that would increase blood glucose too much. Try and not eat too close to bedtime. Get into deep sleep early in the night. Get the growth hormone release. And understand that it's the delta waves of activity - these sweeping big waves of activity in the neurons - that stimulate the brain to stimulate the pituitary. Because once you understand that, then you have something to anchor to in terms of thinking, "What are the things I can do in waking that will allow me to release more growth hormone?" - which for most people is going to be a good thing.

### **Tool - Low-Level Melatonin Supplementation**

Several times before on this podcast, I've talked about the fact that I'm not a big fan of melatonin supplementation for most purposes. It might be helpful under conditions of jet lag. However, there are a lot of reasons why I personally don't like melatonin. It interacts with the reproductive hormones - testosterone and estrogen - and that whole axis in ways that are unattractive, at least to me. It suppresses puberty during development. It's present in much, much higher doses in most supplements than one would normally make - like a hundredfold - three hundredfold. However, today I'm going to talk about an instance where very low levels of melatonin supplementation might actually be advantageous. And that is aiding the transition to the delta-wave/slow-wave sleep I just described because that's the pattern of sleep and brainwave activity that triggers growth hormone release. So, whereas most melatonin supplements are 1 milligram, 3 milligrams, 12 milligrams - this kind of thing. That is supraphysiological. There are some data showing that microgram - maybe 500 micrograms of melatonin - so, half a milligram - can be beneficial in shifting the pattern of early night sleep toward more of the slow-wave/deep sleep/delta activity and improving growth hormone

release. Not a lot of studies, but the ones that I saw are quality. They were done in subjects that - you know - both sexes, sufficient numbers, etc. So, this is interesting. So, if you're interested in melatonin supplementation, you might think about it just in terms - at very low levels - you know - hundreds of micrograms as opposed to the milligram dosages. Most of the ones out there are going to be in milligram dosages. So, that's one way that some studies have shown that you can increase the amount of growth hormone that's secreted in early phases of sleep. Now, the delta-wave activity and the slow-wave activity in the brain being very important for growth hormone release and growth hormone release being so important for metabolic functions, and peeling away unwanted body fat, and repairing tissues, etc - forces us to ask: Well, what other things can we do in waking in order to increase growth hormone release?

### **Tool - Meditation**

So, let's start with the ones that have a potentially big effect but are a little bit harder to access. And for that, I want to point toward a book - which is really - kind of - interesting. It's not focused on growth hormone, but the book is called "Altered Traits". This is the book. It's an excellent book. "Altered Traits" by Goldman and Davidson - "Science Reveals How Meditation Changes Your Mind, Brain, and Body" - very interesting book. For those of you that are interested in meditation - and perhaps those of you who are not but are considering it - what they talk about in this book is the fact that meditation has two separate lines of effects. One of those lines of effects are things that change your state. So, you're stressed. You sit down. You meditate, and you relax, and you go into a particular state. The other are the changes that occur over time and those are changes in trait. So, personality can actually change with long bouts of - of - of TM meditation or repeated meditation. In any case, the reason we're talking about "Altered Traits" today is because certain types of meditation can get people's brains into states that very closely mimic slow-wave sleep. If you hear snoring in the background, Costello is - it sounds like he's in slow-wave sleep - these big oscillatory snores that he's in 23.6 hours per day. So, what this means is for - for people that are interested in increasing growth hormone, a meditation practice that allows you to get into these slow-wave delta-type frequency activity in the brain may be very beneficial because, as I mentioned before, that's what's gating growth hormone release. It's not just a circadian phenomenon. It's actually controlled by these brainwaves.

I did look up binaural beats. I get so many questions about binaural beats. And it's a really attractive idea, right? Binaural beats - for those of you who don't know - you listen to one frequency of tone in one ear and another frequency of tone in the other ear. And then, the - the brain essentially takes the average of the two - or there's some other - there's some wiring in the brainstem that makes it not quite the average - but takes the average of the two, for sake of discussion. And that frequency is what the brain entrains or maps onto. There are a lot of apps that are claiming that you can get the brain into delta waves using binaural beats. I could not find quality peer-reviewed studies supporting that. But I know there are a lot of fans out there of binaural beats. If you know of any literature that's independent of the company that makes the binaural beat technology - so, unbiased research - please send it my way.

But in "Altered Traits", Goldman and Davidson talk about the fact that people who do 20 minutes of sitting meditation per day can access these slow-wave sleep-like brain states. Now, I've talked a lot on here about non-sleep, deep rest - things like yoga nidra and hypnosis. I'm not aware that those will put people into slow-wave sleep per se - or delta waves per se. So, we're really talking about 20 minutes of more traditional type meditation.

Okay, so we talked about very low doses of melatonin as a way to trigger delta waves and more growth hormone release in sleep. There are signs to support that. We've now talked about a waking behavior of 20 minutes of sort of what I would call standard meditation or just sitting there, concentrating on one's breathing to try and access delta waves. Binaural beats, no science yet. Who knows? Maybe they're signs to support it. If you're aware of it, let me know.

### **Tool - Weight Training / Endurance Training (60-75 mins)**

Now, let's move to the things that one can do that have been shown to have what's - let's just be honest - pretty enormous effects on growth hormone release in waking. And these are things that are very actionable. One of the things that can have a dramatic effect on levels of growth hormone release in waking - as well as in sleep the following night - is exercise. But the key is the type of exercise and the duration. Now, there's a logic to this. There are hundreds, if not thousands of studies, measuring growth hormone - both during, or sometimes after exercise, or the following night. And the conclusion that one takes away from all of these is that exercise has to be of particular duration and intensity in order to get growth hormone release. So, first I'm just going to tell you what I found to be the maximum amount of growth hormone release as it relates to a particular form of exercise. The particular form of exercise is either weight training or it can be endurance training - but the endurance training and the weight training actually have to be limited to about 60 minutes - not much longer. Now, this is important because it's been shown over and over again that if one exercises too long - with weights or endurance exercise - that cortisol levels go high enough that it starts to inhibit the testosterone and even the estrogen pathways. This is why I believe people who overexercise or exercise a lot can lose their menstrual cycles. They stop menstruating. It's why you get suppressions in testosterone if people train too long and too hard. The cutoff has always been - you know - 60 to 75 minutes of the hard work part.

### **Tool - Warming Body Temperature (10 mins)**

It's going to vary a lot from person to person. But in terms of growth hormone, the conditions that seem to lead to the greatest growth hormone release are: (1) Get warm. This is interesting. We're going to talk about temperature. So, a proper warm up seems to accelerate the release of growth hormone once the hard work phase starts. So, 10 minutes of warm up or so was the number that I extracted from all these studies. There's a beautiful review on this, by the way. "Growth hormone responses of varying..." - excuse me - "Growth hormone, arginine and exercise". We'll talk about arginine in a few minutes. That's by Kanaley - K-A-N-A-L-E-Y. It was published in Current Opinion in Clinical Nutrition & Metabolic Care. The Current Opinion journals are - are generally of pretty high quality in terms of the reviews just because they tend to be pretty recent. And then, the references therein are also quite good. So, what does this mean? This means warm up. And when you say

"warm up", it doesn't mean just warm up the limbs and tissues that you're going to use so you don't get injured - actually warm the body. So, there was actually some discussion about whether or not in cold winter months people should wear like a stocking cap - bringing the conditions - making the room warm. So, getting the body warm as a warm up seems to be important because temperature of the body seems to be an important condition or prerequisite for certain patterns of exercise to maximize growth hormone release. So, it's really interesting to me. I have an obsession with how body temperature, light, exercise, and food interact. We're going right there with the fact that if you get warm, you bring up the body temperature a degree or two - or maybe three - and then start exercise - it does appear that high-intensity exercise, but not - again, as in - discussed in a previous episode - not exercise that brings muscles to failure, but close to it. So, if it's weight-bearing exercise, it would be getting close to that final repetitions where you can't complete them, but not pushing through those or even going to failure - but getting close - leads to anywhere from 300 to 500% increases in resting growth hormone levels and 300 to 500% increases in growth hormone the following night when you go to sleep - which is incredible.

### **Tool - Low Blood Glucose During Exercise**

Now, I want to dissect this properly, okay? So, one of the other conditions that seemed to be important, again, was to have relatively low blood glucose. So, it looks - looking a lot like the conditions you need for sleep in order to get maximum growth hormone release in sleep. So, not having blood glucose too high or too low. That's a discussion unto itself. You want to have sufficient energy to do the exercise. But getting warm - not having blood glucose too high or too low. So, probably not eating too close to exercise or not ingesting a lot of sugars during the exercise. That was supported by the fact that ingestion of a sports drink that contains caloric sugar immediately flatlined the growth hormone levels. So, really interesting relationship between insulin, glucose, and growth hormone. So then, doing the training for anywhere from 60 to 75 minutes to maximize growth hormone release.

### **Tool - Cooling Body Temperature After Exercise**

And then, the other interesting thing was that even after the exercise, taking body temperature back down to normal levels relatively quickly seemed to be associated with these big spikes in growth hormone. Otherwise, what would happen is you get these big spikes in growth hormone, but if the exercise went too long or if body temperature remained too high for too long, then you didn't get the second increase in growth hormone the following night, okay?

### **Recap**

So, I hope I made that abundantly clear. Warm up well. Get body temperature up. Exercise 60 to 75 minutes. Don't go to absolute failure if your interest is in growth hormone release - both during the exercise and later that night. And if you can bring body temperature back down to normal levels by cooling off - maybe cool shower, or maybe ice pack, or something, or maybe just - you know - turning off the heat in the room, or going outside - whatever it is. Then, you increase the probability that you're going to increase growth hormone the following night as well. And again, these are big increases 300 to 500%. It's almost like you're getting a second sleep during the day. But if the

exercise is too hard - if body temperature stays too high for too long, you disrupt the whole process and you don't get the effect of increased growth hormone.

## **IGF-1**

Growth hormone is really powerful, but it doesn't work alone. In fact, a lot of the effects of growth hormone are mediated by its effects on the liver. So, growth hormone is released, goes to the liver, and then the liver releases something called IGF-1 - insulin growth factor 1. Insulin growth factor 1 was popular in the neuroscience community as an area of focus because of its ability to trigger improvements in memory and learning after exercise. And indeed, exercise triggers both the release of growth hormone and IGF-1. IGF-1 seems responsible for a lot of the effects of improved memory. Some people report that that is due to increased number of neurons or neurogenesis - birth of new neurons. It's pretty clear that, in humans, that's not what's happening. Yes, in animals - not in humans. IGF-1, nonetheless, has positive effects on memory and cognition. And a great way to trigger IGF-1 release and growth hormone release is through exercise.

## **Sex Differences in Growth Hormone and IGF-1 Peak During Exercise**

Now, the interesting thing - and the reason I'm bringing up IGF-1 here - is that certain patterns of exercise - actually duration of exercise - have different effects on IGF-1 and growth hormone depending on whether or not the exercise is done by men or women. There's what we call a sex-dependent effect. And the sex-dependent effect is as follows. In this particular study and several others, what they - what they did is they had people exercise. They measured growth hormone and IGF-1 levels from the blood before, during, and after exercise. And they could see when their - the greatest increases occurred. This was standard sorts of resistance exercise. So, some squats. There was a - there was a sprint-like activity. It kind of - it doesn't really matter what the specific exercises were. None of them were to failure. These were in - kind of - the 10 repetition or less range - 6 sets. So, kind of standard weight training stuff that anyone might do. But what was interesting is that women were able to access the biggest peak in growth hormone and IGF-1 early in the exercise - so, in the first 30 minutes. So, what this means is even - if you just have 30 minutes, at least for women, there's going to be a big increase in growth hormone and IGF-1 in the first 30 minutes. For men, the biggest increase occurred later in the - in the exercise - which was 60 minutes or so total.

And so, the sex-dependent effects are interesting. They point to the fact that things like cortisol, testosterone, and estrogen - which of course vary in different levels in men and women - are going to impact the release of things like IGF-1 and growth hormone. And yes, they did control for all sorts of things like diet and they controlled for weight and prior experience. It's actually a quite nice study. If you'd like to check it out. It's by Pierce et al. - "Growth Hormone and Insulin-like Growth Factor-I Molecular Weight Isoform Responses to Resistance Exercise Are Sex-Dependent" - in *Frontiers in Endocrinology* - fine journal - in 2020. So, it's quite recent. So, what does this mean? This means if you're exercising and you want growth hormone release, warm up. Do the type of exercise we've been discussing. Women, in the first 30 minutes, is when you're going to get the maximum benefit in terms of growth hormone and IGF-1. Men, you have to keep going for the entire

60 minutes. So, don't tap out early if you're interested in getting the growth hormone and IGF-1 release. And the same conditions apply about then cooling down and not making the exercise last so long that you don't get the increasing growth hormone the following night.

My experience thus far in doing this podcast is that people fall into one of two categories. There are the "just tell me what to take" people - the people that are really eager to try supplements and maybe even prescription compounds. And then, there are people who are a little bit more shy about supplementation. They are more focused on what they can do with diet, and behaviors, and things of that sort. I don't have a bias either way. I try and offer tools that are supported by the scientific literature and I always point to safety margins. There are supplements that can increase growth hormone to a considerable degree. And no, these aren't growth hormone itself - although, that of course will increase growth hormone to a considerable degree. We will talk about prescription drugs at the end - not just growth hormone, but some other things that are quite prominently in use right now - in particular, in the entertainment industry. They're - it's pretty interesting compounds.

### **Tool - Arginine**

But first, let's talk about supplements. So, this has been known about for some time. But arginine - the amino acid arginine - as well as the amino acid ornithine, can increase growth hormone levels substantially. Now, arginine has a number of effects. You can get it from food. You can get it from supplements. Some people take it in pill form or capsule form. Some people will actually take it by IV - but intravenously. The levels and the amounts of - of arginine required to get big growth hormone release increases is pretty substantial. Some people will take arginine before bedtime. Some people will take it before exercise. The prerequisite, again, is low blood glucose. Blood glucose is high, it's going to quash the effect. The amounts of arginine that people take are anywhere from 3 grams to 10 grams - or sometimes even more. Although, this is definitely a case of more is not better. There is a threshold at which growth hormone release is actually blunted by taking more than 9 grams of arginine. Now, 9 grams of arginine orally is a lot of pills. It's at minimum 9 pills. And it can cause some GI disturbance. People can feel nauseous. Some people will throw it up. Some people get some constipation, or diarrhea, etc. - or just stomach aches. I'm certainly not suggesting people do this - they're not - that they take arginine. But that's the reason why most of the studies that looked at the role of arginine on growth hormone levels did it by IV - intravenous infusion. So, what's interesting, however, is that whether or not it's by mouth or by vein, taking arginine can dramatically increase growth hormone release. And the levels - or the amount of increase was anywhere from 100 on the low end - but anywhere from - basically from 400% to 600% above baseline. So, these are huge increases in growth hormone.

Now, I've never tried arginine. Arginine is out there for a number of different purposes. One of them is to increase growth hormone. Some of the supplements out there to increase growth hormone include arginine and ornithine. Arginine does have the effect of - of dilating arterials and it basically increases blood supply. The arginine pathway is involved in vasodilation. It's actually the pathway that's downstream of a lot of drugs that are used to treat things like erectile dysfunction. And anytime people have problems with peripheral blood flow of any kind, they focus on compounds

that will either disrupt the enzymes or will adjust the levels of amino acids to get more vasodilation. So, taking arginine for the purpose of increasing growth hormone will also have the effect of dilating blood vessels. And for people with blood - excuse me, with heart conditions - that - that actually can be a serious issue.

Now, here is something really important and interesting to note - which is that increasing arginine levels with the specific goal of increasing growth hormone release can actually short-circuit the effects of exercise on growth hormone. Several studies that I looked at looked at the interaction of taking arginine and the exercise, or just the arginine, or just the exercise alone. And so, you don't - unfortunately - if growth hormone increases your goal - you don't unfortunately get to increase growth hormone 800% by taking arginine and exercising. It always seems to be clamped at about 300% to 500% increases - still large increases. So, I make that point for several reasons. First of all, be aware that arginine has these other effects on vasodilation. Take those seriously if you have a heart condition or take them seriously, in any case. Second of all, you can supplement with arginine - not exercise - and get these big increases in growth hormone by taking them before sleep. But if you're taking the arginine before exercise, you're going to short-circuit or clamp the effects of exercise on growth hormone, okay? So, it's something that one could use, but it doesn't have a synergistic effect with exercise. The two more or less cancel each other out. Not to zero, but you end up with the same effect you would had you done one or the other. So, hopefully that's clear.

### **Tool - L-Citrulline / Ornithine**

The other thing is if one's goal is really to increase arginine in the blood - for whatever reason - arginine may not actually be the best way to do that. Because of the way it's metabolized in the gut, it doesn't have access or get access to the tissues that you're most interested in, in terms of increasing growth hormone or vasodilation for that matter. In that case, there's something else called L-citrulline - which has powerful effects on vasodilation - powerful effects on - potentially on - growth hormone levels via the arginine pathway. But basically, L-citrulline acts as sort of a donor - or let's - it's - kind of - a biological prerequisite for arginine and can lead to even bigger arginine increases than you would get if you took arginine itself. And so, L-citrulline is out there. Keep in mind that anything that dilates the blood vessels will lower blood pressure. So, L-citrulline - yes, will lead to increased blood flow for whatever purpose you want to use it for - whether or not that's pumps in the gym or whatever. It also can lead to big increases in arginine and growth hormone, but it will lower blood pressure. So, be aware of that but - and understand that the biology isn't so straightforward. L-citrulline may actually be the better way to get arginine increases than arginine itself.

And ornithine can also increase growth hormone - although, that's also through an indirect pathway. And nowadays, there isn't a lot of focus on ornithine as a way to increase growth hormone. That was - kind of - all the rage in the '90s - not so much anymore. Nowadays, the people who are really in the know for this stuff tend to focus on L-citrulline. And if you're interested in L-citrulline or arginine, I highly recommend you go to our old friend - good friends - [examine.com](http://examine.com). Because there you can put it into the list. You can just put search and it's totally free. And it will tell you that blood



pressure will be slightly decreased. Power output in the gym will increase. There's very strong effects on blood glucose. Fatigue is reduced notably. Big increases in nitric oxide. That's also related to the increase in vasodilation. Plasma arginine very high - excuse me - notable effects. Very high support for studies - which allow people more training volume - aerobic exercise. Arterial stiffness is brought down. There's a huge list of things. Increase in growth hormone. So, two studies showing this was done double-blind. Great. You always want to see double-blind/placebo-controlled. This was only done in males - not in females - unfortunately - just have data from males. But increases in growth hormone. It's a small but a real significant effect. And again, from quality studies. So, there's a huge number of effects there. And some of the other - kind of - more interesting ones about L-citrulline that you might not have thought about are things like muscle oxygenation. As we scroll down, decreases in c-reactive proteins. So, a lot of the same things that you might expect - expect, excuse me - from the same sorts of compounds we saw before. The takeaway here is if you want to increase growth hormone, think about the arginine pathway. But arginine itself might not be the best direct route to get there. L-citrulline might be a better option. But please do consider and take very seriously the effects on blood pressure.

### **Growth Hormone Changes Across The Lifespan**

So, we've been talking about big effects from supplementation or exercise on growth hormone - this extremely powerful hormone. And one thing to note is that the profile of growth hormone as we age changes. I mentioned that earlier, but it's important to understand how it changes. One - one thing that's particularly interesting to me as somebody who's in his 40s is that it's actually between ages 30 and 40 that the amount of growth hormone that you release each night is reduced by two to threefold. That's really incredible. You know, we hear so much about testosterone levels going down as we age or estrogen levels going down. But if you recall from the testosterone and estrogen episode, we talked about the fact that if you really look at the data - just for instance on testosterone - there are men in their 90s - and they are not rare, it turns out - that are making as much testosterone and DHT - dihydrotestosterone - as they were in their 20s, okay?

So, we hear so much nowadays about how testosterone levels are dropping, sperm levels are dropping, etc. And I don't dispute that. I talked about that in that episode. But it's clear that testosterone levels vary tremendously from person to person and just getting older does not necessarily mean that testosterone levels are dropping. Growth hormone levels, it seems, are dropping when people are in their 30s and 40s. And they're dropping substantially. And that seems to be the case across the board. You're just not going to find people in their 40s, 50s, and 60s that are making as much growth hormone as they were in their teens and 20s. And as somebody who - I feel really good - but as somebody who definitely noticed that as I got into my 40s, that even if I slept the same amount, I wasn't feeling quite as - I would say - able to recover from exercise or wound healing - even with the same amount of sleep. And I was trying to optimize a great number of things. This business of growth hormone became of particular interest to me. And since the ways to manipulate growth hormone in men and in women are so straightforward - and since everybody goes through this age-related decline very dramatically - it seems to me that the things that we're supposed to be doing anyway - like exercising - like trying not to eat too close to bedtime

- trying to optimize sleep - all of these are wonderful tools that we should be pursuing and perhaps using. And they can actually offset the two to threefold decrease, right? If we're talking about a two to threefold decrease for people that are in their 30s and 40s - and then we're talking about increases from exercise or from - maybe from supplementation - but certainly from exercise - of 300 to 500% - well then, all of a sudden we're in a position to actually offset the age-related decline in growth hormone completely just through behaviors. And I think that's quite interesting and quite powerful.

### **Tool - Sauna**

Now, I'd like to discuss a way that anyone can increase their levels of growth hormone dramatically. And when I say dramatically, I mean dramatically. I'll get to the numbers in a couple minutes, but we have to remember how growth hormone is released in the first place. Remember, it all starts in the brain - in the hypothalamus. The hypothalamus is a brain area that controls things like sexual behavior, temperature regulation, circadian behavior - meaning when you want to be awake and when you want to be asleep, aggression - all of that. There are other brain areas involved too, but it has a rich collection of different neurons involved in all these very basic functions. Now, as we talked about, the releasing hormones - the growth-hormone-releasing hormone comes from neurons in the hypothalamus. Those then communicate with the pituitary and the pituitary releases growth hormone. And then, the growth hormone acts on all these different tissues - muscle, liver, cartilage, etc. - body fat. It makes them use energy. That's why you lose body fat when growth hormone levels are high. It makes you grow muscle, strengthens bones, etc. Now, one of the things that has a profound effect on growth hormone levels - growth hormone release - is temperature.

Now, the data on this are very strong. And the data come from both animal studies and human studies. So, there are a number of studies that have explored how making animals cold or hot can increase growth hormone. And if you're guessing which direction this is going to go, you can probably imagine that making animals or people warmer is the way to go if you want to increase growth hormone. Now, anytime you're going to increase temperature of yourself, or anyone else, or an animal - it is risky. I want to be really clear about this. Not everyone should engage in the behaviors I'm about to describe. But - and I should just say, the reason it's risky is it doesn't take much of a temperature increase in the brain to cook the brain - to cook neurons. And after that point, neurons can't come back. And people can die from hyperthermia. We have a much greater range in terms of cold. You can also die of hypothermia. You can freeze to death. But you have a much greater range of getting cold than you do warming up the brain. However, there are really strong data pointing to the fact that sauna - a.k.a. deliberate hyperthermia - not too high, however - that sauna can increase the release of growth hormone and other hormones. And what's so dramatic about this literature is the size of the effects that are reported.

So, first of all, let's talk about these temperature increases. And yes, I will refer to things that people can do even if you don't own a sauna. Because I realize not everybody has a sauna in their backyard or has access to a sauna. So, first of all, recall our study about exercise - where warming

up a few degrees before the exercise led to bigger and quicker increases in growth hormone during the exercise bout itself. So, that already pointed in the direction that temperature was important. Now, the - the degrees - no pun intended - that we're talking about increasing body temperature is by entering saunas that are somewhere between 176 degrees Fahrenheit - so, that's 80 degrees Celsius - and all the way up to like 210-215 degrees Fahrenheit. I personally know people that go even higher than that, but they've trained themselves to deal with - with very high heats. Again, high heat is dangerous. You must clear this with your doctor. Now, what happens in high heat? A couple things happen in high heat. First of all, you start getting bigger stroke volume of the heart - kind of like an exercise. Once you get well trained in endurance activity, your stroke volume - the amount of blood that your heart can pump each time - gets larger. You dilate the blood vessels, right? There are a lot of things that happen also. You're sweating. Your body's trying to unload heat. Dilation of blood vessels, arginine, increases in heat. We're starting to see and hear a common theme. But it appears that getting into - I'm not talking getting the body up to 212 degrees Fahrenheit. I want to be very clear. Not talking about getting the body up to 100 degrees Celsius. That would be terrible. You would die. But entering environments where it's very hot for short periods of time - anywhere from 20 minutes to 30 minutes - where the temperature is 80 degrees Celsius to 100 degrees Celsius or 175 degrees Fahrenheit - more or less - to about 210 degrees Fahrenheit - more or less - has been shown to increase growth hormone release sixteenfold. That's right, sixteenfold. That's 1,600%. Now, there are also effects on other hormones - prolactin, cortisol, etc. So, the pattern that was described in this study - there have been many studies now - "Endocrine effects of repeated sauna..." - were - were done in 17 humans. This was from doing this repeatedly. So, it wasn't the first time they did this. They actually had to do this 3 days in a row. And the pattern was to get into the sauna for 20 minutes followed by a 30-minute cooling period. Remember, you don't want to spend long periods of time at high heat. You can cook your brain and other tissues. Be very careful as you approach this if you decide to. But 30 minutes - excuse me, 20 minutes - followed by 30 minutes of cooling - followed by 20 minutes sauna again - led to a fivefold increase in growth hormone. And then, by doing that day after day after day - on the third day, you would see these huge increases of like sixteenfold - up to sixteenfold. And there are now many studies like this. This was described a few years ago. But since then, there have been a number of other studies that have pointed in the direction of deliberate hyperthermia - but not too hot that you kill yourself in order to increase growth hormone. And I know I keep highlighting the dangers there. But again, anytime you're going to mess with heat, you have to be cautious. You have to be careful. So, standard sauna can - can be useful.

### **Tool - Wearing Plastics & Other Alternatives**

If you don't have access to a sauna, one way that people do this - we have to look to our friends, the wrestlers, right? They wear "plastics" - which are basically body suits that are fairly inexpensive that you can buy on any online purchase platform - I should say. Some people - in the old days before they had these plastics things so readily available, I actually knew people that wrap themselves in garbage bags, and then throw on sweats and a hoodie, and then go out for a jog. Again, you have to be really careful - especially on a hot day, overheating can equate to death. But that's another way to heat up. You don't actually need a sauna. I've known people who will do this in hotel rooms while

they're traveling. They'll turn on the heat - you know - make a hot bath. They won't actually get in the bath, but they'll fill the room with steam and heat. And they'll put on a hoodie and some sweatshirt - sweatpants - and they'll sit there with wool socks on. And they'll get warm for 20 minutes. Then, they'll take a cool shower. And then, they'll do it again. I guess when the hotel's paying the water bill, you don't - you don't worry about it too much. Some people, of course, own saunas. There are a lot of ways to do that. I have friends who are in the military who made saunas out of cars while they were overseas - all sorts of things. You do have to be careful. I know I've said it many, many times. I just don't want anyone to hurt themselves.

But these increases in growth hormone are tremendous. And what they probably stem from are increased activity of neurons within the hypothalamus that stimulate growth hormone release from the pituitary. And that's probably because the growth-hormone-releasing hormone neurons in the hypothalamus sit very closely and may even be intermixed with some of the neurons in the hypothalamus that regulate heat and body temperature. Remember, metabolism is, in part, a heat - it's like a furnace of how much energy you're consuming and using for building or for energy usage purposes. So, sauna can be very, very interesting. And again, it's 20 minutes, 30 minute cooling, 20 minutes again. Proceed with extreme caution. But nonetheless, these are pretty extreme effects in terms of their abilities to increase growth hormone levels.

Along the lines of temperature and hormones, I just want to mention a very recent study just came out March/April 2021 - "Endocrine Effects of Repeated Hot Thermal Stress and Cold Water Immersion in Young Adult Men". Unfortunately, it was just in men. They didn't look at women. But nonetheless, I think the data are relevant to everybody, as a general theme. This is Podstawski et al. I will put a link to the study in the caption. And they looked at testosterone, prolactin, cortisol, etc. And what they found was that the sauna does indeed lead to a significant decrease in cortisol - a stress hormone - a hormone that you want to be released early in the day when you wake up. But sauna definitely led to a significant decrease in cortisol, but did not change testosterone, DHA, or prolactin levels. So, that's interesting. And it turns out that the cold did affect some of these hormones, but the results there were a little bit more mixed. So, the takeaway here is that heat seems to have positive effects on growth hormone - big effects. It seems to have positive effects on reducing cortisol levels. And it does not seem to have effects on things like testosterone, DHA, or prolactin directly. You can imagine that a shift in any hormone is going to alter the levels of other hormones down the line - sort of indirect effects. But in terms of direct effects, just during or immediately after the sauna bath, there were no effects.

### **Tool - Prescription Growth Hormone**

So, we've talked about diet, supplementation, behavioral tools - and of course, we talked about the underlying biology and logic. And hopefully, you heard the safety precautions for all of those. Now, I'd like to just briefly talk about the prescription side of all this. There are, as we know, many people taking growth hormone because it's been prescribed to them by a doctor. And presumably, there are people taking growth hormone even though it has not been prescribed by a doctor - which is none of my business. But the point here is that most all of the hormones that we make have been

synthesized. So, there are versions of them in little bottles or little ampules that people can inject. Here are a couple of important things to consider if you're going to go that route. First of all, talk to a physician, right? They actually are only legally available through a physician. Second of all, anytime you're injecting something, you're going to shut down your own production. That's the way that the hormone system works. If you take thyroid hormone, you won't make thyroid hormone - at least in the long run. If you take testosterone, you will shut down your own production of testosterone. If you take estrogen, the system's a little more resilient. But eventually, you will shut down your production of estrogen. And the same is true for growth hormone. So, a decision to go that route of taking something is often - not always - a decision to do it forever. However, if you're willing to sustain a period of being without a given hormone - some people can do things and then, take a - stop taking them. And then, wait out the period in which they're not making testosterone, estrogen, or growth hormone. And then, it will come back - sometimes. And sometimes it won't.

### **Tool - Sermorelin & Other Peptides**

There's a - kind of - new area that's developing now that I think deserves our attention - not because I'm encouraging it, but because it is happening. And in keeping with the science and in keeping with trying to keep things modern, it's worth us discussing. And those are peptides. So these days, you hear a lot about peptides. I'd like to clarify a little bit about what peptides are. Peptides is a really huge category of biological compounds. Peptides are just strings of amino acids, right? So, we've talked about L-tyrosine, arginine, ornithine. Those are amino acids. Those are individual amino acids. And those are put together into little small peptides or they're what are called polypeptides - which are just longer peptides. Turns out that for any substance like growth hormone or growth-hormone-releasing hormone, it's made up of different amino acids in different sequences - just like your genes are made up of As, and Gs, and Cs, and Ts - nucleotides in different sequences. It's like a recipe. Peptides tend to be short sequences of amino acids that resemble a hormone enough or resemble some other peptide enough that it can lead to the similar or same effects when you inject them. So for example, we make growth-hormone-releasing hormone from our brain which stimulates growth hormone from the pituitary. You're probably getting tired of me saying that by now.

But people now will take things like sermorelin - S-E-R-M-O-R-E-L-I-N - sermorelin - which is not the entire peptide sequence of growth-hormone-releasing hormone, but it's a subset of those. And when people inject it before they go to sleep at night - it's typically how it's done - on an empty stomach - then, that stimulates the release of growth hormone from the pituitary. So, this is not taking growth hormone. This is taking the stimulating hormone - or what's often called a secretagogue - or a mimic, alright? It causes a - a secretion of the hormone that one wants. People do this for thyroid hormone, too. Some people are doing this by prescription with a real medical need. Other people are doing it for just "longevity reasons", which - kind of - falls into that gray zone of they wouldn't die without it, but they want to enhance their life. And so, they're doing that because they believe it's the right thing for them. Prescription - sermorelin is prescription. Do they work? Yes. Do they shut down your natural production of growth-hormone-releasing hormone? Well there, the answer is yes. But some of these peptides actually have the effect of changing gene

expression. Remember, way back to the beginning when I was talking about hormones, they can actually change gene expression. And they can actually set pathways in motion for continued production of a hormone - even if you stop taking the compound. Now, that can be good or bad, because as you recall, growth hormone in big - big increases in growth hormone that are short-lived, like sauna - or - I - you know - I should say exercise or arginine - or sauna - it seems like has these huge effects - or early nights - you know - first phase of sleep early in the night - these sorts of things. Those are transient, but when one is injecting over and over a constant level, you can put into action gene expression programs that can be long-lived. And let's say you have a particular tumor in the body. Tumors will grow when they see growth hormone - even if it - that tumor is unhealthy for you, right? You've got growth of tissues all over the body. So again, I'm not saying whether or not people should do these things or not doing them.

One thing I do know is that they are in very prominent use in the movie industry - people who want to peel off body fat quickly. They do increase recovery time. They increase healing rates. People are also injecting things like gastric peptides. They're actually stomach peptides that we talked about in the previous episode - things related to the ghrelin pathway and other things from the liver - that can improve the rate of tissue and wound healing. You can bet that in the upcoming Olympics, a lot of people are using peptides and compounds. And I'm not pointing fingers at anyone in particular. It's just this is separate from hormone augmentation of like injecting GH or injecting testosterone. People are now working further up the pathways. Other names of some of the peptides are things like ipamorelin, tesamorelin. Some of these have clinical uses. Others have just been made as compounds for people in the - kind of - longevity field or the self-augmentation field, if you will. So again, not promoting their use. But they're definitely out there. And so now, if you hear about them - or someone's talking to you about them - now, hopefully, you have a better understanding about their underlying biology. And you can think rationally about whether or not they are the right decision for you, okay?

## **Recap**

Once again, covered an enormous amount of material. Hopefully now, you understand thyroid hormone, and what it does, and a little bit about its mechanism - or maybe a lot. And growth hormone, and what it does, and how both of them take care of our metabolism. They dictate how many nutrients we can eat and make use of. They can pull from body fat stores, repair muscle, repair cartilage. They really are incredible compounds. And they are actionable. There are things that we can do - like getting that early phase of sleep - perhaps supplementing with arginine, maybe not - hopefully getting adequate exercise - warming up properly - not making the exercise too long or too intense will help - maybe sauna or things like it - you know - deliberate, safe hyperthermia - the emphasis on "safe" - might be things that are of use. Regardless, even if you're not interested in the thyroid or the growth hormone pathways, this brings to a close our month on hormones. And so now, hopefully you understand not just thyroid and growth hormone, but the logic that underlies thyroid hormone, growth hormone, estrogen, testosterone, why we eat, why we stop eating, cholecystokinin, ghrelin. If these names don't mean anything to you, then perhaps go back and listen to those episodes. But regardless, I hope that you come away from this with a

deeper understanding about these hormones - which are so powerful in controlling the way our brain functions - and the interplay between the brain and hormones because it is really a bidirectional conversation. The brain is telling the body what hormones to make. The hormones are influencing all the tissues of the body, but also telling the brain whether or not to eat more, or grow more, or think more, etc. So, I really appreciate your time and attention.

### **Conclusion**

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And I mentioned supplements this episode. I often mention supplements. They are certainly not necessary. But for those of you interested in supplements, we've partnered with Thorne - T-H-O-R-N-E - because Thorne has the highest levels of stringency in terms of the quality of the ingredients and the amount of the ingredients in each capsule, tablet, powder, etc. If you want to see the supplements that I take - as well as get a discount on any of those or any of the supplements that Thorne makes, it's Thorne - [T-H-O-R-N-E.com/u/huberman](https://thorne.com/u/huberman) - and you can get 20% off any of the supplements they make. I should mention Thorne works with the Mayo Clinic. They've partnered with them. They work with all the major sports teams. So really, the highest levels of stringency. We're quite happy to be working with them. And last but not least, thank you for your time and attention - and above all, for your interest in science.