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. 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 are controlling the development of our brain and our bodies. After we are born, they are 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. 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. Today is going to be rich with information, rich with actionable tools. As always, the idea is to spell out an organizational logic so you can come away from this episode. In fact, the entire month on hormones really understanding at some level what these things we call hormones are and how they work. 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. 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. 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? First of all, I want to acknowledge the question as a valid one because I see this every once in a while out there. People will say, well, walnuts are in the shape of the brain and therefore they are good for your brain or a 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 there since your 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. Beats 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 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 that organ that the particular substance like vitamin A or fatty acids and so forth might bend. Or 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 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. 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 throughout stevia as an artificial sweetener and several people reached out to correct me that stevia is not an artificial sweetener. It is a non-caloric sweetener and you are correct. I lumped artificial and non-caloric 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 non-caloric 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. It probably cancels to zero in terms of its impact on blood glucose provided. It is not at concentrations that are super, super sweet. Ingestion of anything that is very sweet whether or not 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. 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. I appreciate that you allow me to make corrections every once in a while. I must speak here and the opportunity to make corrections keeps us all on the same page. Please do keep any feedback that you have about particular things I cover here coming my way. 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 its 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-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 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 ultra marathoner 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 muscle 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, it's 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 from 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. 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 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, hypothalamus, 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, ganadotropin 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 thyroid tropin or thyroid releasing hormone. You also have growth hormone releasing hormones. Any time you hear releasing chances are those are neurons that are in your brain and the extend little wires we call axons into your pituitary and the pituitary releases a bunch of hormones into the blood stream and the pituitary releases things that most often have the name of stimulants. So 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 talk about how you have ganadotropin releasing hormone. And then you have the hormone 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 enacted 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. So in the nutrition, the pituitary is letting go of all these hormones into the blood stream that are stimulating different tissues. So for thyroid, it's thyroid stimulating hormone. And then it goes to the thyroid. 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 your male, female, or regardless of what your chromosome or 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. 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 to 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 that 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 hypothyroid all have bulging eyes and are real thin. People have hypothyroid or overweight and they have their eyes are 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. 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 hormone. 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 where it, 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 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 blood streamer, 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 hormones, 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. Any time you're talking about hormones or manipulating levels of thyroid, you absolutely won't 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, but you know, the kind of artisan salt thing has kind of taken off in the foody land, which is great. Some of them 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 provide it 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 composition ratios 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. 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 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, 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 six or eight Brazil nuts contain something like 550 micrograms of selenium. It's also present in fish. So certain fish like yellow fintuna, although nowadays whenever I mention tuna or shellfish, which is the other rich source of selenium people will tell me immediately. They're 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 pork beef has some selenium. But what's interesting if you look at the sources, you know, pork beef turkey chicken cottage cheese eggs brown rice that what you want to understand is that Brazil nuts six to eight Brazil nuts has 550 micrograms of selenium and all the other foods I mentioned at much greater portion size than equivalent to six to eight Brazil nuts either by volume or by calories, they have something like 30 to 50 micrograms of selenium. So if you're not eating Brazil nuts and 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 that bowl of mushrooms, you know, the what is the equivalent to a bowl of mushrooms 12 micrograms of selenium. The daily ration is something in the hundreds to 100 range again, look it up for the area you are, you can see really quickly why think even though things like mushrooms and spinach and milk and yogurt and lentils and cashews and hour into the vegetarian segment in the list that I constructed, you're probably not getting enough selenium. So it's kind of an interesting thing if you're an expirimenter 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 over do 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, there are 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 100, you know, high levels of hundreds 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. 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. Preeclampsia is seizures that are related to blood pressure issues during 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 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. There 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 statistically significant one. And the other one is a reduction in acne, which is interesting. I'm guessing that that probably has to do with the thyroid hormone pathway because of the weight 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 into 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. 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 ricerigrain or 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 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 they're 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 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. 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, 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 hormones, the highly processed foods really are terrible. There's so much evidence for that. They sellates 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 in some cases plants that actually lower thyroid hormone. 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 offshoot to 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 there are these inflammatory cytokines. There you have many, many names because there are many, many of them. Interleukin 10 is the one that's anti-inflammatory. Interleukin 6 is the one that's 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. So 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 healthy diet. Still maintain 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. 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, the reason you can recover more quickly from injuries if you have a healthy thyroid and healthy thyroid pathways is because you can consume energy that energy is diverted toward bone repair and muscle repair and cartilage repair. 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, 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 our blueberry is good for your brain or they do ask me, our walnuts is good for your brain because it looks like a brain. We talked about that earlier. The fact of the matter is that what you need are nutrients that support hormones and biological pathways that support the brain. That's the way to think about it. I realize when people ask what should I eat to support my brain, that's basically what they're asking in short form. Keeping your thyroid hormone healthy at healthy levels 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. Do the things, take the things, eat the things that are going to allow you to have healthy levels of thyroid hormone. 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's some telltale signs of having really high thyroid or really low thyroid. I could start listing those off. They're easy to find online as well. I like bulging eyes, inability to maintain weight, shaky anxiety, that's hyperthyroidal, thinning of hair, this kind of thing. I don't want to get into diagnosing hypothyroidism and hyperthyroidism. It's just impossible because you're there and I'm here and we're 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 hypothyroid. Of course, they have synthesized thyroid. If you don't make enough thyroid, you can take thyroid. It's by prescription. If you 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. There are 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. There's also a lot of evidence that for people who menstruate, levels of thyroid hormone can fluctuate dramatically across the menstrual cycle. I'm really going to be a process of experimentation. I don't know that you could, in theory, take blood at different phases of your cycle and figure out whether or not your thyroid hormone was excessively high or low at different phases of the cycle. That's going to be pretty tough to do if you have an entercanologist that's willing to do that with you, terrific. If 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. That makes sense because in ketogenic diets, blood glucose levels are very low. Thyroid hormone is secreted in large part in proportion to how much glucose is in the blood stream. And how much that 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 three, four days, so called cyclic ketogenic diet. Some people are staying ketogenic for long periods of time. Some people six days on, one 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 point me in the direction of some research if you're aware of it. 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 diets. And so if you 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 ketones does out there. They're 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 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. 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. 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 acromagally. It's kind of like a ridging of the forehead. It's actually a bone ridge. They are giant and it used to be called giantism. 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. 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 probably want to do that. 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. 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. It's one of the reasons why our metabolism slows. 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. Not just muscle, not just reduction in body fat, but by metabolizing 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. This is the concern with abuse of growth hormone. 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. 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. Also, the increases that one can get in growth hormone are substantial. 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 10 fold differences from administering the prescription compound. In terms of growth hormone, there are things that can increase growth hormone 3, 4, 500 percent or more. Even though that's a short-lived increase, they can have very powerful effects on metabolism and on repair of tissues. Let's talk about those. 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 remove any treatments, so anything you would add or take away, that's a responsibility of you and your health care provider. 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, that's 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 podcast, as 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. 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 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 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, growth hormone releasing hormone neurons 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 of 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 the 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 brain waves during sleep, which most of you probably are not, you might be measuring slow wave sleep or deep sleep using a device like a woofer and aura, 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 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, the 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. 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 100 fold, 300 fold. However, today I'm going to talk about an instance where very low levels of melatonin supplementation might actually be advantageous. That is aiding the transition to the delta wave, slow wave, sleep, I just described, because that's the pattern of sleep and brain weight of activity that triggers growth hormone release. Whereas most melatonin supplements are 1 milligram, 3 milligrams, 12 milligrams, this kind of thing. That is super physiological. 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 both sexes, sufficient numbers, etc. This is interesting. If you're interested in melatonin supplementation, you might think about it just in terms of at very low levels, hundreds of micrograms, as opposed to the milligram dosages. Most of the ones out there are going to be in milligram dosages. 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? Let's start with the ones that have a potentially big effect, but are a little bit harder to access. For that, I want to point toward a book, which is really interesting. It's not focused on growth hormone, but the book is called Altered Traits. 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 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, sounds like he's in slow wave sleep. He's big, oscillatory snores that he's in 23.6 hours per day. So, what this means is 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 brain waves. I did look up BINORAL BEATS. I get so many questions about BINORAL BEATS. And it's a really attractive idea, right? BINORAL BEATS, for those of you who don't know, you listen to one frequency of tone, and then the brain essentially takes the average of the two, or there's some other wiring in the brain stem that makes it not quite the average. But, it 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 BINORAL BEATS. I could not find quality peer review studies supporting that, but I know there are a lot of fans out there of BINORAL BEATS. If you know of any literature that's independent of the company that makes the BINORAL BEAT technology, so unbiased research, please send it my way. But, in alter 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 Yoganidra 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've talked about very low doses of melatonin as a way to trigger delta waves and more growth hormone release in sleep. They're science 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. BINORAL BEATS. No science yet. Who knows? Maybe their science to support it. If you're aware of it, let me know. Now, let's move to the things that one can do that have been shown to have what's, let's just be honest, a 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 exercise is 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. That's why you get suppression into testosterone if people train too long and too hard. The cutoff has always been 60 to 75 minutes of the hard work part. 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 one, 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 a varying, excuse me, growth hormone, arginine and exercise. We'll talk about arginine in a few minutes. That's by cannelly, K-A-N-A-L-E-Y. It was published in current opinion in clinical nutrition and metabolic clear. The current opinion journals 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 this is 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 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. And 300 to 500% increases in growth hormone the following night when you go to sleep which is incredible. Now I want to dissect this properly. 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. 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 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. 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 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 percent 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 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 release goes to the liver and then the liver releases something called IGF1 insulin growth factor one insulin growth factor one. 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 IGF1 IGF1 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 humans that's not what's happening yes and animals not humans IGF1 nonetheless has positive effects on memory and cognition and a great way to trigger IGF1 release and growth hormone release is through exercise. Now the interesting thing and the reason I bring you up IGF1 here is that certain patterns of exercise, actually duration of exercise have different effects on IGF1 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 IGF1 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 sprint like activity, 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 success 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 IGF1 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 IGF1 in the first 30 minutes for men the biggest increase occurred later in the in the exercise which was a 60 minutes or so total. 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 and men and women are going to impact the release of things like IGF1 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 quite nice study of you like to check it out it's by Pierce at all growth hormone insulin glow factor one molecular weight. So the most important response to resistance exercise are sex dependent in frontiers and endocrinology find journal in 2020 so it's quite recent so what does this mean this means if you're exercising and you want to grow 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 IGF1 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 IGF1 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 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 know 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 there it's pretty interesting compounds 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 so some people will take arginine before bedtime some people 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 three 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 blunt by taking more than nine grams of arginine now nine grams of arginine orally is a lot of pills is at minimum nine pills and it can cause some GI disturbance right people can feel nauseous some people 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 raise was anywhere from 100 on the low end but anywhere from basically from 400 to 600 percent of the baselines 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 including arginine and ornithine arginine does have the effect of dilating arterials and it basically increases blood supply argin the arginine pathways 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 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 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 are going to short circuit or clamp the effects of exercise on growth hormone 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 hopefully that's clear 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 and in that case there's something else called el citralline which has powerful effects on on vasodilation powerful effects on potentially on growth hormone levels via the arginine pathway but basically el citralline is access sort of a donor or it's kind of a biological prerequisite for arginine and can lead to even bigger arginine increases then you would get if you took arginine itself and so el citralline is out there keep in mind that anything that dilates the blood vessels will lower blood pressure so el citralline yes will lead to increase 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 and understand that the biology isn't so straightforward also straightforward el citralline 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 that people who are really in the know for this stuff tend to focus on el citralline and if you're interested in el citralline or arginine I highly recommend you go to our old friend good friends examine dot 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 glucose fatigue is reduced notably big increases in night 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 wrote but 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 el citralline that you might not have thought about or things like muscle oxygenation as we scroll down decreases in c reactive protein so a lot of the same things that you might affect 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 else citralline might be a better option but please do consider and take very seriously the effects on blood pressure 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 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 2 to 3 fold 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 talk 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 dhd dihydrotestosterone as they were in their 20s okay so we hear so much nowadays about how testosterone levels are dropping sperm levels are dropping et cetera and I don't dispute that I talked about that in that episode but it's clear that testosterone levels very 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 a particular interest to me and since the ways to manipulate growth hormone in men and in women are so straight forward 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 2 to 3 fold decrease right if we're talking about a 2 to 3 fold decrease for people there 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 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 makes them use energy that's why you lose body fat when growth hormone levels are high 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 dressing 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 hypothermia. 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 they're really strong data pointing to the fact that sauna aka deliberate hypothermia 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. 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 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 about itself. so that already point in the direction that temperature was important now that the degrees no pun intended that we're talking about increasing body temperature is by entering sauna that are somewhere between 176 degrees Fahrenheit so that's 80 degrees Celsius. and all the way up to 210 to 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 and again high heat is dangerous you must clear this with your doctor. 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. 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 happen also you're sweating your bodies trying to unload heat. dilational blood vessels are gene increases in heat we're starting to see and hear a common theme but it appears that getting into I'm not saying 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 less has been shown to increase growth hormone release 16 fold that's right 16 fold 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 repeat a sauna were were done in 17 humans this was from doing this repeatedly so it wasn't the first time they did this they had to do this three 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 sauna followed by 30 minutes of cooling followed by 20 minutes on again led to a five fold increasing growth hormone and then by doing that day after day after day on the third day you would see these huge increases of like 16 fold up to 16 fold 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 be useful if you don't have access to a sauna one way that people do this we have to look to our friends the wrestlers 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 what wrapped 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 sweat pants and they'll sit there with 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 worry about it too much some people of course own sauna 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 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 released 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 pod Strauski at all 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 lines or indirect effects but in terms of direct effects just during or immediately after the sauna bath there were no effects 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 is 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 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 A's and G's and C's and T's 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 here saying that by now but people now will take things like sermoralin, S-E-R-M-O-R-E-L-I-N sermoralin 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 secrete a gog or a mimic it causes a secretion of the hormone that one wants people will 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 sermoralin 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 that can be 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 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 are 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 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 growing 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 G.H. or injecting testosterone people are now working further up the pathways other names of some of the peptides are things like hypermoral and test some moral and 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 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 their 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 hypothermia 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 the I wrote hormone growth hormone estrogen testosterone why we eat why we stop eating colicist to kinding grill and 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 think more etc so I really appreciate your time and attention if you like this podcast and you're finding it useful please recommend it to other people if you are on YouTube please subscribe please leave us a comment or feedback in the comment section we do read all of the comments and we use those comments as ways to inform future content of the podcast if you listen to it in audio form please subscribe on apple and or Spotify that really helps us on apple you have the opportunity to leave us a 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of those or any of the supplements that thorn makes thorn th o r n e dot com slash the letter u slash huberman and you can get 20% off any of the supplements they make I should mention thorn works with the Mayo clinic they 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 I thank you for your time and attention and above all for your interest in science