Huberman Lab #21 - How to Lose Fat with Science-Based Tools

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Introduction

Welcome to the Huberman Lab podcast where we discuss science and science-based tools for everyday life. I'm Andrew Huberman and I'm a professor of neurobiology and ophthalmology at Stanford School of Medicine. This podcast is separate from my teaching and research roles at Stanford. It is, however, part of my desire and effort to bring zero cost to consumer information about science and science-related tools to the general public. In keeping with that theme, I'd like to thank the sponsors of today's podcast.

Our first sponsor is InsideTracker. InsideTracker is a personalized nutrition platform that analyzes data from your blood and DNA to help you better understand your body and help you reach your health goals. I've been getting my blood work done for many years now, and that's for the simple reason that only through quality blood work - and now, through the advent of DNA tests - can one really get a clear picture of what's going on with their health. Things like metabolic factors and hormones - all the various triglycerides - these are things that can only be measured from a quality blood test. And now with DNA tests, you can get an additional window into your current health status and the trajectory of your health. What's really wonderful about InsideTracker is that you don't just get numbers back about the specific levels of various hormones and metabolic factors. You also get a lot of information about what you could or should do in order to adjust those numbers to put you on the course to better health. So, for instance, it will give recommendations about particular foods to eat or avoid - particular exercise regimens that you might want to adopt - and the frequency of those regimens - in order to move those markers in the correct direction. InsideTracker has also added a new feature that makes tracking your progress and analyzing your data even easier. For those of you that use a Garmin fitness tracker such as the Garmin Watch, that's now compatible with their platform. So, you can couple your data from your Garmin with your blood and DNA for even more personalization and insights on your health. However, if you don't have a Garmin device, there's still a lot that you can get from InsideTracker and their tests. If you'd like to try InsideTracker, you can visit insidetracker.com/huberman. And if you do that, you'll get 25% off any of InsideTracker's plans. Use the code "huberman" at checkout. That's insidetracker.com/huberman to get 25% off any of InsideTracker's plans and use the code "huberman" at checkout.

Today's podcast is also brought to us by ExpressVPN. ExpressVPN is a virtual private network that keeps your data secure and private. It does that by routing your internet activity through their servers and encrypting it so that no one can see or sell your data. I'm familiar with the effects of not securing my data well enough. A few years back, I had my bank accounts hacked. I don't know exactly how it happened, but it happened. And it was a terrible amount of work to have that reversed and secured. The great thing about ExpressVPN is I don't even notice that it's running. I haven't on my computer. I turn it on any time I work - at home or when traveling - or in a cafe - airport - anywhere. And it runs in the background. It doesn't change anything about the interface with my computer or the Wi-Fi. It just secures my data and it secures any information about what I happen to be searching for, etc. I don't feel like I have anything particular to hide except my bank account passwords and things of that sort. But with ExpressVPN, it basically makes everything

secure. You can't be tracked. And no one can access or steal your data, which is terrific. So again, I use it when I'm traveling and when I'm at home. If you want to start protecting your internet activity using ExpressVPN, you can go to expressvpn.com/huberman and you'll get an extra three months free on a one-year package. That's expressvpn.com/huberman to get three months free on any of their one-year packages.

Today's podcast is also brought to us by Athletic Greens. Athletic Greens is an all-in-one vitamin mineral probiotic drink that gives you a total foundation of vitamins and minerals and probiotics to support your health and well-being. I've been using Athletic Greens since 2012. And so, I'm delighted that they're sponsoring the podcast. I started using Athletic Greens and I still use Athletic Greens once or twice a day because it's the simplest and most straightforward way to get my basis of important vitamins, minerals, and probiotics taken care of. All of those things combined to support various aspects of my health such as brain health - such as gut health. For instance, there's a tremendous amount of evidence now showing that probiotics support gut health and that the gut-brain axis is important for things like focus and cognition - as well as for immune function and various aspects of physical health like metabolism. The list sort of goes on and on. With Athletic Greens, it has all these vitamins, and minerals, and various other things that are good for me. And I actually really like the way it tastes. So, the way I use it is once a day - sometimes twice a day. I'll mix it up with water. I add a little bit of lemon or lime juice. I think it tastes great without the lemon or lime juice. But when I add that, it's truly delicious to me. And I'll drink that first thing in the day - midmorning sometimes instead - and sometimes again in the later afternoon. I'm able to drink Athletic Greens late in the day and not have it keep me awake. If you want to try Athletic Greens, you can go to athleticgreens.com/huberman. And if you do that, you can claim a special offer. They'll give you five free travel packs which make mixing up Athletic Greens while you're on the road really simple and easy. And they'll give you a year's supply of vitamin D3K2. Vitamin D3, as many of you know, you can get from the sun. But many people, even if they're already getting a lot of sun exposure, still have vitamin D3 levels that are too low. And vitamin D3 is very important for a huge number of cardiovascular, immune, metabolic, and other aspects of health. So once again, if you go to athleticgreens.com/huberman, you'll get the five free travel packs and a year's supply of vitamin D3 and K2.

Today is the third episode in our series of episodes about physical and athletic skill performance and skill learning, in general. And today, we're going to talk about the science of tools for fat loss. And fat loss is something that interests a large number of people. Many people want to lose fat. Many people are athletes who need to lose fat. And in general, we know that having body fat percentages that are too high is unhealthy for us. And most people struggle to lose fat. Most people struggle to lose weight, generally. But most people especially struggle to lose body fat or what we call adipose tissue. Now, this is a huge topic on the internet. There's a lot of controversy. Today, we're going to talk about some things related to fat loss and that are powerful for fat loss that I'm guessing most of you have never heard about before. You may have heard about a few of them, but I'm guessing you haven't heard about all of them. This episode is going to be rich with science-based tools that are gleaned from a variety of aspects of the literature - including the use

of cold, including brown fat, including something called beige fat. We're going to talk about something called NEAT. We're going to talk about all sorts of aspects of fat loss that are governed by your nervous system. And this is, I think, an important gap that's missing in the discussion about fat loss. You can hear a lot of information out there about the role of things like insulin and various diets - like ketogenic diets, or vegan diets, or Mediterranean diets. And there's some great stuff out there, and there's some really terrible information out there, and there's a lot of controversy. We did a number of episodes talking about the role of hormones on metabolism and the role of food on mood and well-being. So, if you're interested in those topics, please check them out. I will touch a little bit on hormones today - things like insulin and leptin - just a little bit. But today's episode is mainly going to be focused on how the nervous system - neurons - and some of the cells they collaborate with, like glia and macrophages - how those encourage or can encourage accelerated fat loss - because it turns out they can. Remember, your nervous system - which includes your brain, and your spinal cord, and all the connections that they make with the organs of the body - governs everything. It's the on switch and the off switch for your immune system. It's the on switch and the off switch - it turns out - also for fat burning. And so, the nervous system and the role of the brain and other neurons has been vastly overlooked in the discussion about losing fat.

Now, I would be remiss and I'd probably come under a pretty considerable attack if I didn't just acknowledge upfront a core truth of metabolic science - and also of neuroscience, frankly - which is that calories in versus calories out - meaning how many calories you ingest versus how many calories you burn - is the fundamental and most important formula in this business of fat loss and weight management, in general. There's simply no way around the fact that if you ingest far more calories than you burn, you're likely to gain weight. And a good portion of that weight is likely to be adipose tissue fat. It's also true that if you ingest fewer calories than you burn, that you will lose weight and that a significant portion of that will come from body fat. What portion depends on the number of factors, but that simple formula is important.

On a previous episode, I mentioned the complications with the statements of, "A calorie is a calorie." And indeed, there is evidence from, for instance, Robert Lustig, who's a pediatric endocrinologist at UC San Francisco - has talked about how highly processed foods change the way that we utilize food and can lead to higher incidences of obesity and other metabolic syndromes that go against the idea that a calorie is a calorie and that's it. So, a calorie is a calorie as a unit of energy and we need to accept and acknowledge this calories in - meaning calories ingested - versus calories burned formula. But the calories burned portion is strongly influenced by a number of things that you can control that can greatly accelerate or increase the amount of adipose tissue or the proportion of adipose tissue that you burn in response to exercise and food.

So, your hormones are important. Your thermogenic milieu - meaning how warm or how cold your body is - how cold you make it - how warm you make it. But also, your level of metabolism - your levels of thyroid hormone. And something that's hardly ever discussed, but is well supported by the scientific literature - how much innervation - meaning how much connectivity there is between your nervous system and fat.

Today we're going to talk about the - the fact that your body fat of various kinds - and there are several kinds of body fat - are actually innervated by neurons. Neurons connect to your body fat and can change the probability that that body fat will be burned or not. So, your nervous system is the master controller of this process and it plays a strong role in the calories out - the calories burned - component.

So as usual, we're going to discuss a little bit of science. I promise I won't go too deep into lipolysis and all sorts of things related to fat oxidation. We're going to break down that process into two important steps. And if you can understand those two important steps, then the rest of the tools will be very straightforward to understand and manage. And I do believe that today you will walk away with many new tools that you could incorporate into any kind of fat loss regimen that will greatly accelerate that process because it's grounded in quality peer-reviewed science. Throughout the episode, I'm going to talk about some behavioral tools. In fact, I'll mostly talk about behavioral tools. I will also talk about compounds/supplements. Many of you are into supplements. Some of you aren't and that's fine. For those of you that are into supplements, an important issue in a discussion about supplements for fat loss or otherwise is going to be the quality of those supplements and the accuracy about what's in those supplement bottles, and tablets, etc. I usually mention this at the end of the podcast. But this podcast, we've partnered with Thorne - T-H-O-R-N-E - because Thorne, we believe, has the highest levels of stringency in terms of the quality of the compounds in their supplements and the amounts of those compounds. If you want to see the supplements I take, you can go to thorne.com/u/huberman. You can see the supplements that I take. That will also allow you to get 20% off any of those supplements or 20% off any of the other supplements that Thorne makes. Thorne has partnered with the Mayo Clinic and all the major sports teams, so there's a very strong basis for their stringency. Again, you don't need to use supplements. I'm certainly not encouraging anyone to use supplements if that's not your thing. But if you're going to use supplements, make sure that your supplement source is one of very high quality. With that said, I want to get started and talk about the various tools for fat loss and how neuroscience - neurons - control fat loss.

5 Pillars of Metabolism: Sleep, Essential Fatty Acids, Glutamine, Microbiome, Thyroid

Before I do that, I want to set the context correctly and extract some of the key takeaways from previous episodes because if your foundation of health, and your foundation of hormones, and your foundation of metabolism isn't right, it's going to be very hard to get the most out of any kind of exercise or fat loss protocol. In previous episodes, I talked all about the science and the details - going into particular protocols. We don't have time to do that now and I want to get to the new material. However, there are a couple bins - a couple items - that you should make sure you're getting correctly. And if you're not perfect about these, don't worry about it. Most people are not perfect about them. I'm certainly not perfect about them. But we should all be striving to get quality and sufficient sleep. I did four full episodes on sleep and how to get better at sleeping through things like light exposure, temperature, timing your sleep correctly for your so-called chronotype - if you're a night owl or a morning person. That's the first four - or I think five episodes - of the Huberman Lab podcast. Get your sleep right. Get your light exposure right. Avoid bright light in your

eyes at times you want to be asleep and get bright light in your eyes at times you want to be awake. So, get your sleep right.

The other thing is essential fatty acids. I talked about this in the food and mood episode, but I also talked about it during the hormones episodes. We need fatty acids. They are vital to so many aspects of our health. You don't have to get them from supplements. You can if you want to, but you need to get them from your food. They are essential. There's a reason there's an "E" - the essential part there. Of the fatty acids, there are multiple kinds. But for the antidepressant effects, where the - the levels of fatty acids that will promote good mood, and also healthy metabolism, and will start to shift the needle in the right direction on bloodborne cardiovascular factors - the key thing is to get the levels of EPA that you ingest above 1,000 milligrams per day. So, that doesn't mean just taking 1,000 milligrams or more of say fish oil, or krill oil, or whatever your preferred source is. It means getting above 1,000 milligrams of EPA, which may require that you ingest more essential fatty acids than just 1,000 milligrams per day. That, of course, can be done through food sources - things like fatty fish. Or if you're not - if you're not into eating fish, you have quality meats that are grass-raised can do that. There are other sources of essential fatty acids - of course, also from plant sources. So, look those up online. It's really easy to find. But the research in the literature shows that you want to get above 1,000 milligrams of EPA per day because that's when you can best support your metabolism and position yourself for good fat loss.

As well, for people who have cravings issues - they - they crave sweets all the time - I talked about this in the gut-brain episode - and hormones and food - that you have neurons in your gut that are craving - they're seeking essential fatty acids and they're craving and seeking amino acids from your food. Now, these are not supplements that they crave per se. They're craving those things because that's what your body needs and your brain needs. But those same neurons will respond to sugars. And so, many people who are craving sugar can satisfy that sugar craving by giving the neurons, so to speak, what they actually want - which are amino acids and essential fatty acids. That includes EPA, but also things like glutamine - an amino acid that can really reduce sugar cravings if you take a teaspoon of that or even a tablespoon of that a few times a day. You have to ease into that a little bit because some people can get a little bit of GI distress from too much glutamine. But glutamine has also been shown to improve symptoms of leaky gut. It's a powerful amino acid. And yes, you can also get it from food - things like cottage cheese are high in glutamine, etc.

And then finally, you can't really position yourself to have a strong metabolism if your iodine levels aren't correct and your thyroid levels aren't correct. You can overdo iodine so you don't want to do that. A lot of table salt has iodine added to it, but some people need to add iodine - they - by ingesting things like kelp, etc. But one of the best ways to support the thyroid system and metabolism, in general, is to make sure you're getting enough selenium - sometimes called selenium - each day. Simple way to do that is to ingest the highest concentration of selenium food that I'm aware of - which is Brazil nuts - one, or two, or three of those per day. You'll have more than

enough selenium to meet the thyroid needs. You don't want your selenium to be too high. You don't want a diet too high in anything.

So again, sleep, sufficient EPAs - glutamine, if you have issues with leaky gut or sugar cravings can really help get your gut microbiome right. I may have - missaying that. But get your gut microbiome right. That does not necessarily mean you need to ingest probiotics. You can if you want to, but you can also just simply ingest a serving or two of fermented foods per day. That can greatly assist. So, things like sauerkraut/kimchi. Every culture has a different source or sources of fermented foods. Those can really help the - the gut microbiome. And then, make sure that your thyroid hormone is supported through the ingestion of sufficient iodine - not too much - and sufficient selenium - not too much, okay? Sleep, EPA, glutamine, fermented foods, iodine, selenium - that sets the basis for how things like exercise, cold, and some of the compounds, and other things that we're going to talk about today that are - I'm guessing - truly going to be truly new to many of you that can really increase the burn factor in the equation of calories in versus calories burned, okay?

Mindset / Belief Effects on Fat Loss

So, on the one hand, we have this reality of calories in versus calories burned. However, I would also be remiss if I didn't mention an incredible study that was done by my colleague, Alia Crum at Stanford. She's a faculty member - a professor - in the psychology department looking at how belief effects, just thinking, can impact the effects of things like exercise on weight loss. These are just incredible results. What they did was they took subjects who were hotel service people that would clean the hotels and come in and change the - the linens and so forth - divide them into two groups. One group, they were told, moving around and doing your duties for your job meet the standards for US guidelines for activity and movement, etc. - and a basic lecture about how movement is good for you, etc. But mostly just that their daily activities met the standards for the US. The other group, however, was given a bunch of information about how movement and their daily routine was very good for cardiovascular health. It could be good for weight loss, etc. And then, they tracked these subjects over a period of many weeks. The take home message from this study was that simply being told that movement is good for you, can lead to weight loss, etc. - led to significantly more body fat loss, waist-to-hip ratio changes in the direction that most people would want - but essentially a slimming down, if you will - and all sorts of other positive effects on things like cardiovascular health - simply by the knowledge that movement and exercise can help various health markers.

So, this is remarkable and it speaks to the power of the nervous system and the power of belief in governing aspects of our body and our physiology that one would otherwise think were outside our conscious control. Now, of course, any of you that think scientifically - which I imagine if you watch this podcast or listen to this podcast, is all of you by now - probably thinking, "Well, maybe they just moved around more, or maybe they stood up and sat down more, or maybe they - they did something else that was different." And indeed, there's a strong possibility that they did things differently than the other group. But the mere knowledge that exercise is good for you - that movement is good for you - shifted their behavior and their physiology in the direction of enhanced

weight loss, fat loss, etc. So, how we think about a given set of activities affects how we perform those activities. And how we think and perform - about and perform those activities has a real effect on our physiology.

So, somewhere between the hard-and-fast rule that governs fat loss and weight loss - which is: If you ingest more calories than you burn, you'll either maintain or gain weight - typically, you'll gain weight - although, not always. If you ingest about as many calories as you burn, you maintain weight, typically. And if you ingest fewer calories than you burn, typically you'll lose weight. That's the - kind of - rule of fat loss. And yet, we also have these belief effects which show - and this has been replicated again and again - that how we think about a process - whether or not we think it's beneficial - can change our physiology in ways that can be beneficial to us. Somewhere in between those two extremes of hard-core metabolic science and belief effects, lie a bunch of protocols that are grounded in quality peer-reviewed science and in physiology that you can leverage to increase the rates of fat loss. And so, that's what we're going to talk about today.

Our Brain Talks To Our Fat

I love this topic. And it's not that I'm so obsessed with fat loss, but rather the first project I ever worked on in science was thermogenesis and fat loss. I joined a laboratory as an undergraduate. And the guy I worked for loved to explore new compounds and how they impacted thermogenesis. And so, we looked at how things like MDMA/ecstasy - how antipsychotics/antidepressants - various weight loss drugs that were on the market - how those impacted body temperature, and fat loss, and metabolism. And we just had so much fun doing it. So, if you detect a smile on my face, that's - that's what that's about. And I also learned a lot and I also came to really appreciate that this tissue of our bodies - adipose tissue and fat - we think of as just this unfortunate thing - this like - we're told it's a core energy source if we ever entered a famine and that's all true, etc. You come to realize that these cells in our body - they are there as fuel for the furnace of our body, which is our metabolism. And there's a third player. And that's where it really gets interesting. That the nervous system - neurons - has the opportunity to turn up the intensity of that furnace. It has the opportunity to increase the amount of heat that we produce and therefore the amount of energy that we burn. And I was also really intrigued by something which is that growing up, I think we all know people who can eat a ton and never seem to gain any body fat - or people who seem to eat very little and seem to gain body fat very easily. And I was always intrigued by that. And it turns out there are a number of different factors that relate to that. But the nervous system is the one that we can really control - both through behaviors and what we eat, but also in terms of this thing that we call thermogenesis.

Dinitrophenol (DNP)

There was one particular story I want to relate to you that does not suggest any protocol. In fact, I'm going to discourage you from following this protocol. Please do not try the compound that I'm about to describe. One of the favorite things that we like to do in that lab was to find rare compounds and test them. And at the time, I was reading about thermogenesis and I learned about a compound that was actually discovered in the armory factories of World War II. And it was discovered because

women, in particular, who were working in these factories would take a - a brush and dip it in a compound - or a paint, rather - and they would then paint the numbers with a stencil onto things like bombs and - and ammunition of various kinds. And they were losing weight like crazy. And it turns out that occasionally they'd lick the brush and then they would go back - just to get a - a sharper point on the brush. And then, they would paint onto these various - you know - bullets and - and missiles and so forth - bombs and so forth. And they started shedding all their body fat. And many of them losed - excuse me, lost - a lot of weight - a significant portion of their weight without changing anything else that they were doing, what they were eating, etc. It turned out that that compound is something called dinitrophenol (DNP).

And over the years, dinitrophenol (DNP), has gained popularity in some niche cultures - mainly bodybuilders - athletes - even in the - kind of - modeling industry. It is a absolutely terrible compound for anyone to use because it's highly fatal if your body temperature goes too high. Hyperthermia will kill you. And indeed, many people have died using dinitrophenol as a weight loss drug or attempting to use as a weight loss drug. But dinitrophenol really illustrates a principle which is that your - your metabolism includes things like thyroid hormone and growth hormone, etc. But your body temperature and the way you utilize energy is controlled by your nervous system. And the way dinitrophenol works is by changing the neurons and the way that the neurons that connect to fat change the way fat burns up. So, we are not going to suggest - I am not suggesting that you use dinitrophenol.

However, there are other things that you can do that can change the relationship between these neurons and the fat of your body in ways that can powerfully accelerate fat loss. And I don't know why we don't hear about these things more, but probably because most of what you see out there on the internet focuses more on what you could eat and should eat or shouldn't eat. It concentrates on exercise regimens, which we will also talk about. But the burn factor - your thermogenic environment - is one of the - if not the most important factors - in this business of fat loss. And since I am a neuroscientist, that's what we are going to talk about.

Two-Part Process of Losing Fat: Mobilization and Oxidation

So, let's talk about fat utilization. Let's talk about how fat is converted into energy, which is sometimes also called fat burning. What I'd like you to know is that this is a two-part process, okay? In reality, there are many biochemical steps. And if you log onto the internet or you open up a textbook and you want to learn about fat utilization, you are going to see a lot of chemistry. And I'm happy to go deep into that chemistry if you'd like, but I think most of you are probably interested in: What are the leverage points? Where can you exert control over this process in ways that benefit you? So, I'm going to focus mainly on those, okay? This is not to upset the aficionados and I will put in some nomenclature.

But here we go. There's two parts to this process. One is fat mobilization. And the second is fat oxidation or utilization, okay? So, the first thing that has to happen for body fat to get burned up or used and reduced is that it has to get mobilized. And that's a process called lipolysis. But I actually

don't care if you know the name "lipolysis". You just have to move that fat out of the position that it's in. You have to get it out of the fat cells, alright? Fat cells can be visceral - around our visceral organs - or it can be subcutaneous - under our skin. Most people are thinking about subcutaneous fat when they think about fat.

So, here's the deal. And if you want more detail, great. I'll touch on that in a bit. But basically, stored fat has two parts that are relevant here. It's got the fatty acid part and that's the part that your body can use. And that's attached to something called glycerol and they're linked by a backbone. So, already probably too much chemistry for both of you. But what you want is you want to break the backbone. So, if you just can remember - to mobilize fat, you got to break the backbone between glycerol and these fatty acids, okay? That's accomplished by an enzyme called lipase. But you can forget all that if you want. Remember, we're just trying to mobilize fat. So, the first step is to get those fatty acids moving around in the bloodstream - to get them out of those fat cells. And then, they can travel and be used for energy. And that second part - remember, first part is mobilization. The second part is oxidation. Is then, those fatty acids - those are potential fuel. They're just potential fuel. But you haven't burned the fat yet. You've just moved it out of your fat cells. They're going to go into cells that can use them for energy. And once they are inside those cells, they're still not burned up. You need to oxidize them. Think, "Oxidation is the burnup part." They need to be moved into the mitochondria. And then, they can be converted into ATP - into energy.

So, just to really zoom out again to make sure I don't lose anybody. You've got to mobilize the fat. Then, you have to oxidize the fat. You have to - in other words, you have to mobilize it. Then, you actually have to convert it into energy. If you just mobilize it and you don't convert it into energy - you don't oxidize it - it can be returned to body fat. And many of the things that the nervous system can do is to increase the mobilization of fat, but also the oxidation of fat, okay? So, you have two opportunities to burn more fat. And both of those opportunities are governed by your nervous system - by neurons that literally send little wires that we call axons into fat and release chemicals that provide a stimulus for more of that fat to be mobilized. And then later, for more of that fat to be burned up. So, we could go really deep on this, but I'm not going to go much deeper than that because this isn't a biochemistry of fatty acid metabolism lecture. This is about how to burn fat using your nervous system. But remember, there's a mobilization step and then there's an oxidation step. I think any one of you - all of you - should be able to internalize that. Mobilize, then oxidize, okay? Mobilize, then oxidize.

Critical Role of Adrenaline/Epinephrine

So, what are these neurons that connect to fat doing? What are they releasing exactly? How do they actually increase fat mobilization and how do they increase fat oxidation - burning of fat? Well, there are a couple of things that they release that encourage that process. And the main one that you need to know about is epinephrine or adrenaline. The conversion of these fatty acids into ATP in the mitochondria of cells is favored by adrenaline, okay? And adrenaline is released from two sources. Adrenaline is released from the adrenal glands, which sit atop our kidneys and our lower back. And it's also released from the so-called sympathetic nervous system - although, that name is

a bit of a misnomer because it has nothing to do with sympathy. It has to do with stimulating alertness and promoting action of the body.

There's a big mistake in the literature that is finally being corrected among those who know. The mistake in the literature is that the adrenal glands and the release of adrenaline is what stimulates fat loss and fat oxidation. In fact, it was thought for a long time that adrenaline swimming around in your body of when you're fasted - because fasting can increase adrenaline - or when you're engaging in intense exercise or when you're stressed - is going to promote fat oxidation. That's actually not the case. The adrenaline that stimulates fat oxidation - the burning of fat - is coming from neurons that actually connect to the fat, not hormones like adrenaline that are swimming around in your system. It's a local process. And this is very important because it means that what you do - the specific patterns of movements - and the specific environment you create that can stimulate these particular neurons to activate fat. Meaning to release fat, to mobilize it, and then to burn it is going to be a powerful lever that you can use in order to increase fat loss. So, what have we said so far? We've said that you've got to mobilize, and you've got to burn fat, and that your nervous system is in control of that process. It's not just about calorie deficit.

Fidgeting & Shivering

Okay, so let's talk about how to activate the nervous system in ways that it promotes more liberation, movement, mobilization of fat, and more oxidation of fat. So, one of the most powerful ways to stimulate epinephrine, which is also called adrenaline, from these neurons that connect to fat - and to thereby stimulate more fat mobilization and oxidation - is through movement. But I'm not talking about exercise. The type of movement that I'm referring to is extremely subtle. And some of you may be familiar with this type of movement. But I'm guessing you're probably not familiar with what I'm about to tell you, which is that shiver - or shivering - is a strong stimulus for the release of adrenaline/epinephrine into fat and the increase in fat oxidation and mobilization. But shiver is not just induced by cold and there are other subtle forms of movement that can greatly increase fat metabolism and fat loss.

There was a group in England during the 1960s and '70s that discovered a pathway by which subtle forms of movement can greatly increase fat loss. This is the work of Rothwell and Stock. It's very famous in the thermogenesis literature. And I learned about this early on when I was an undergraduate. And I asked, "How did they come across this?" And here's how the story goes. They were aware that some people overeat and yet don't put on weight. Other people overeat even just a little bit and they seem to accumulate extra adipose tissue. Now, this is long before all the discussions about microbiome, and hormone factors, and - you know - it was long before it many of the hormone factors besides insulin had even been discovered. What they did was they examined people who overate and did not gain weight. And what they observed was that those people engaged in lots of subtle movement throughout the day. In other words, they were fidgeters. And that's what they called them. I'm not going to do the - the British accent version of fidgeters. But Rothwell and Stock were British. What they found were people that overeat but don't gain weight as a consequence - and in fact, many people who had low levels of body fat - had a lot of resting

tremor. Not of the parkinsonian-type, but they would bounce their knee while they were sitting. When they would talk, they would engage in very angular movements. They were sort of electric. In fact, now in science, I was chuckling about this as I was diving back into this literature because the other day I heard a wonderful lecture on a totally different topic from a colleague of mine. And we all adore him. He's over in Europe and he's this tremendously successful scientist, so we like to poke fun at him. And every one of his movements is incredibly electric and staccato. And he's rail thin and he eats like a horse. And so, it fits very well into the discovery of Rothwell and Stock who discovered that fidgeters - people that bounce their knee, people that have a head bob while they're listening, people that not a lot, people that stand up and sit down a lot throughout the day, and people that pace - burn anywhere from 800 to 2,500 calories more than the - the control group in the experiments that they looked at.

And indeed, there's been a modern look into all this, and these numbers checked out. That simply moving around a lot, even if those are subtle movements, greatly increases the amount of energy that you burn. And people who overeat, the people who can have the - the second or the third donut - or donuts at all - and don't seem to put on weight to the same degree, they are people that move around a lot even when seated. There are people that will often move their limbs very quickly as well. They - there even have been studies that have explored other things that correlate with fidgeters. Fidgeters stand up very quickly at the end of a lecture or they start to gather their things very quickly, whereas non-fidgeters don't. So, dogs like my bulldog Costello, definitely not a fidgeter. Every movement is incredibly slow and deliberate. Sitting down is a process. If you ask them to sit down, it's sort of a slow motion. If you ask them to get up and he kind of looks at you, sighs, and then stands up. The fidgeters are the opposite of that, right? You say, "How are you doing?" And they go, "Great!" So, even sometimes their speech will be accelerated - although, not always - but staccato movements, fidgeting, etc.

And in 2015 - and again in 2017, there have been studies that have been - have explored this using some modern metabolic tracking. And indeed, simply moving a lot - being a fidgeter, bouncing your knee, standing up and pacing several times or many times throughout the day - led to considerable amounts of fat loss and weight loss when people were ingesting the same amount of food. If they overate, they were able to compensate and burn off that food. And if they were trying to lose weight and they incorporated this fidgeting protocol of deliberately trying to fidget more and move around during the day - pace, stand up more quickly, sit down more often, sit down and stand up more often rather - they found that they greatly increased their weight loss anywhere from 20 to 30% increases. And in some cases - you know - there are the - always those few people who burned a lot more. It seems to work best in people who are already slightly overweight. So, for people that are overweight who are kind of averse to exercise, fidgeting might actually be a good entry point. And 800 to 2,500 calories is a considerable amount of calories when you really think about it.

Now, why am I telling you this? Well, there's clearly a tool to export from this, which is that you can increase the amount of calories burned without having to go on additional long runs. I do hope that people are exercising regularly because it's so important for other aspects of brain and body health.

But nonetheless, we all - we are all time limited and we are not all so ready to embrace exercise. I have a family member who has been slowly coaxed into exercise. But if I were to tell her, for instance, "You need to fidget more.", she'd probably go for it. So, this is a powerful way to increase the calories that are burned.

Now, that's great. And you can think about the protocols. But I want to nest that protocol in what I said before, which is that fat is controlled by these neurons and the epinephrine they release. You might say, "Well, how could these little micro movements lead to so much caloric burn?" And that's where it really gets interesting. Rothwell, and Stock, and others that they worked with subsequently found that these little fidget movements - the engagement of certain aspects of our musculature that are nothing like exercise. It's not these large coordinated or rhythmic body movements, but rather subtle little bits of fidgety movement. And here I am doing a lot of fidgety movement. As an example, tapping the pen - this kind of thing. I was probably that kid class most of the time. And I was like - I try not to irritate people. But I was definitely a knee balancer. I'm not particularly lean or - or not. But - you know - I was definitely - this is a common activity for me. People that do that sort of thing - it turns out that it's not the kind of caloric burn that we normally think of - of like, "Oh, you're running, lifting weights, swimming, yoga, etc." Those subtle movements of our core musculature - not just the core, but all our limbs in our core - in our musculature - those low-level movements - they trigger epinephrine release from these neurons and they stimulate the mobilization of fat. And then, that fat is oxidized at higher rates. And I find this fascinating, I wish more people knew about it, which is why I'm telling you about it today. This has nothing to do with exercise in the traditional form. And yet, 800 to 2,500 calories per day - that's a considerable amount of fat oxidized. If you are in a calorie maintenance mode or a - if you're sub-caloric, that's going to add to still additional fat loss. The data on this are tremendous. I'll link to a few studies. If you're really interested in learning about what's called NEAT - which is non-exercise activity thermogenesis - NEAT.

So, what's the protocol? Fidget. If you're really interested in burning calories and you already exercise and you want to burn more, or you don't have the opportunity to exercise, or your reversed exercise for whatever reason - fidgeting movements, staccato movements, standing up, walking around, pacing - all the sort of nervous activities that we're so critical of and other people and sometimes in ourselves - are actually mobilizing and oxidizing a lot of fat and a lot of energy. And while this probably won't compensate for chronic overeating, the caloric burn from this is considerable and very likely can offset a - you know - a meal that had excessive calories or a - kind of - steady state of accumulating - of eating too much. And it also starts to open up all sorts of thoughts and discussion about - you know - when you travel, you tend to eat foods that are - kind of - outside your normal ones. We tend to eat foods that aren't so great for us. We also tend to be a little bit more sedentary when we travel. We're on the plane, etc. But all of that aside, just the use of something like low-level movement - and it's almost like a tremor, but also these short, small, fidgety movements. I'm intentionally doing a lot of these today, so you have examples that you can use that - to select from, if you'd like. These can have a major effect on fat loss.

Two Ways of Using Shivering To Accelerate Fat Loss

And it raises a second tool. If these low - meaning these small movements that we engage in - trigger epinephrine/adrenaline release from these neurons of the sympathetic nervous system that innervate fat and increase fat mobilization and oxidation - now, it should make sense why shivering is one of the strongest stimulus - stimuli that one can incorporate to stimulate fat loss. Now, shivering is almost always associated with cold. We think shivering, we think cold. Because when we get cold, we shiver. And there are two ways that shivering can increase fat loss. And there are several ways that you can use shivering - you can leverage shivering and you can leverage cold to accelerate fat loss. But you have to do it correctly. And most of the people that are using cold - and frankly, suggesting cold - as a means to increase metabolism fat loss are suggesting the exact wrong protocol. In fact, the one I'm going to recommend is 180 degrees in the opposite direction to the typical protocol that you'd hear about. So, let's talk about how to use cold and how to leverage shiver as a particularly strong stimulus to increase fat loss through mobilization and oxidation of these fatty acids.

So in recent years, there's been a growing interest in the use of cold for various things like improving stress tolerance, improving metabolism, recovery from exercise. I've talked about a number of those things and the uses of cold on this podcast. In fact, did an episode on how to supercharge performance through palmar cooling - cooling the palms in specific ways - or the bottoms of the feet. And if you're interested in that and how to improve performance, and, endurance, and strength, you can check out that episode. But most people out there are using cold exposure typically by taking cold showers or by getting into cold water of some other kind - a lake, or a river, or a cold bath, or an ice bath. And they are doing that probably with mixed goals - meaning they both would like to increase their metabolism and burn fat as well as improve mental resilience.

White, Brown & Beige Fat

Since today we're talking about accelerating fat loss through the use of science-based tools, I want to emphasize a study that was published in Nature just a couple years ago showing exactly how cold increases metabolism and fat loss. So, we have several kinds of fat - three kinds in fact. We have white fat - white adipose tissue. And we have brown fat - or brown adipose tissue. And there's a third kind which is beige adipose tissue. White fat is the type that we traditionally think of as fat - subcutaneous fat. And it is not particularly rich in mitochondria. It is there as an energy storage site. And we have to mobilize the fat out, as we talked about before, and burn it up elsewhere. Brown fat largely exists between our shoulder blades and on the back of our neck - between the scapulae. And it's rich with mitochondria, which is why it's called brown fat. And brown fat has a particular biochemical cascade whereby it can take food energy and can - it can take food, basically - break it down and convert it into energy within those cells. And there's some additional steps involved. But unlike fatty acids from white fat which have to travel elsewhere, get broken down in mitochondria, and converted into ATP, etc. - used by the mitochondria, rather - brown fat is thermogenic. It can actually use energy directly. It skips a step. And I don't want to get diverted by

going into all the - the biochemistry of it. Beige fat is sort of in between. It's white fat that could be brown fat because it has some mitochondria in it but not as many as brown fat.

Now, cold exposure does several things. Making ourselves cold can allow us to build up mental resilience because getting into cold of any kind - doesn't matter if it's a cryochamber, doesn't matter if it's a cold day and you forgot your sweater or your parka, it doesn't matter if it's an ice bath, or you're lying down in the snow - cold causes the release of adrenaline from your adrenals and it causes the release of epinephrine from these neurons that connect to fat. Now, the big effects of cold on metabolism and fat burning are going to be through two routes. One is that if you expose yourself to cold, you have the opportunity to trigger activation of brown fat as well as to convert more beige fat into true brown fat. So, you essentially create a stronger or a hotter furnace. That's the way to think about brown fat. It's like a furnace. And so, with this principle that we started with of calories in versus calories burned, what you're doing is you're increasing the amount of burning. You're increasing the burn of energy by increasing the intensity of the heat inside you, so to speak, okay? I'm talking here as - kind of - metaphorically.

Succinate

Now, how can you do that? Well, if you get into cold water, or an ice bath, or a cold day and you try and remain calm and resist shivering, you actually short circuit this mechanism for increasing brown fat thermogenesis. The paper published in Nature shows that it is shivering itself that causes the brown fat to increase your burning, your burn rate, and your metabolism. And it works like this. When you get into cold and you shiver, the shivering - those - that low-level movement of the muscle - those small movements - triggers the release of a molecule called succinate - S-U-C-C-I-N-A-T-E - succinate. And succinate acts on the brown fat to increase brown fat thermogenesis and fat burning overall. It actually increases body heat through this brown fat thermogenesis pathway. And it also over time can increase the amount of brown fat by converting beige fat into true brown fat. Now, how much cold exposure and how often - that's the key. But before I give that detail or set of details - remember, if you resist the shiver, you are not going to get the increased metabolic effect because you are not going to get the succinate release. So, if you want to get your body heat - your thermogenic level - to go up, you need to shiver.

So, now we have the NEAT - the non-exercise activity thermogenesis - so, low levels of activity, as I described before - which are done away from cold. Maybe do them in cold as well. As well as shiver in response to cold. And so, the shiver itself is valuable for triggering the release of succinate. In fact, succinate is being evolved now by various drug manufacturers as a potential treatment for obesity - although, it hasn't really hit the market in its final form yet. Succinate is powerful for its effects on brown fat.

Exact Protocols: (1-5x Per Week)

So, how many times a week do you need to expose yourself to cold will depend on how much fat you are trying to lose and how much you are trying to increase your metabolism. There are studies that describe positive effects on fat loss of exposing yourself to cold either through cold shower, or

through ice bath, or other cold water. It doesn't have to actually have ice in it provided it's cold enough. For anytime - anywhere, excuse me - between 1 and 5 times per week. But it turns out that just 1 exposure per week can be valuable.

The question then is: How long to get into that cold environment? And how cold should that environment be? So, first let's talk about how long to get into that cold environment. The answer here might be a little bit different than you might imagine. Most of you might think, "Oh. Well, if 1 minute is good, 3 minutes is better. And if 3 minutes is better, then 10 minutes is best." But remember, the goal is to get the shiver-induced release of succinate so that succinate can trigger the brown fat.

It turns out that if you want to trigger the shiver, what you want to do is to get into the cold and then get out of the cold - and, typically, not dry off. And then, get back into the cold and out of the cold. That will definitely stimulate more shivering than just getting into the cold itself. So, what I'm not referring to is getting into the cold environment like an ice bath and waiting until you shiver and staying there shivering, okay? You also don't want to get hypothermic. And I want to be clear. You want to - you want to get approval from your doctor before you do any of this.

When you get into cold water, there are two factors that will dictate whether or not you shiver - probably three, but let's just talk about the main two. One is how cold it is. So, how cold should it be? And look, if you get into water that's very, very cold, it can actually shock your heart. It can actually give you a heart attack if it's truly, truly ice cold and you're not adapted to that. So, proceed with caution, please. I'm not a physician and I'm not - I don't want to see anyone get hurt.

Cold - just cold enough to be uncomfortable is a good place to start. So for some of you, that's going to be 60 degrees. For some of you, that's going to be 55 degrees. For some of you, it's going to be high 30s, right? Depends on how cold-adapted you are and people vary in terms of how well they tolerate the cold. So, what you need to do is find a temperature that you can get into 1 to 5 - probably 1 to 3 times a week if you really want this to accelerate fat loss. And you want to get in until you just start to shiver. And then, you want to get out and not dry off. Wait anywhere from 1 to 3 minutes and then get back into the cold. Now, you'll notice when you get back into the cold, it'll almost seem soothing. It might actually not induce shiver. It might take away the shiver that you were - that you had.

So, here's a potential - kind of - sets/reps protocol that you can play with. Find a temperature that induces shiver for you. That's going to vary depending on your cold tolerance and how cold-adapted you are. 1 to 3 - maybe 5 times a week - get in until you - or get under the shower or whatever it is until you start to shiver - genuinely shiver. Then after about a minute or so, get out. Spend 1 to 3 minutes out, but don't dry off. Get back in for anywhere from 1 to 3 minutes, but try and access the shiver point again. And you might do 3 repetitions of that. So, it's 3 times in and 3 times out total, okay? That's a great starting place. And what you don't want to do is build up your tolerance so - to

cold so fast that pretty soon you're able to resist the shiver because remember the shiver is the source of the succinate release that will trigger brown fat thermogenesis.

So, if you'd like to see this protocol spelled out, you can access it zero cost at a website, which is thecoldplunge.com. The Cold Plunge is a company. They make cold plunges and they were kind enough to gift one to the Huberman Lab podcast. But I want to emphasize that these protocols are free of cost. The folks at The Cold Plunge are not just interested in marketing their product, but one of their main interests is encouraging people to engage in cold exposure for particular endpoints and goals - like fat loss, resilience, etc. - resisting inflammation. But their main focus is providing people protocols and encouraging people to use cold exposure of various kinds - not just through their products, but through cold rivers, and jumps in the ocean, and things - cold showers - whatever is most convenient and accessible for various people. And so, we needed a place where we could house these protocols in a permanent way. And not just for this episode, but - so, what they've agreed to do is to post the protocols there. This should be very easy to find on their website. This particular protocol we're referring to as the fat loss optimization protocol for lack of a better name and it's really grounded in how cold can be used to induce shiver. And again, it doesn't really matter how you're accessing that cold provided you access the shiver and you're moving from the cold environment to a slightly warmer environment. So, getting out of the cold shower, or getting out of the ice bath, etc. - or out of the cold plunge - and then, back in - because it turns out that the cooling and rewarming process of the body is where shiver kicks in. And so, that's distinctly different than just trying to get into the cold and stay in the cold for as long as possible.

Avoid Cold Adaptation

And if you zoom out a little bit and think about some examples in life, you'll understand why that must be the case. For instance, people who do a lot of cold water swims. You have these polar bear clubs - I think they call themselves - do these cold water swims. I would sometimes see these people swimming back and forth to Alcatraz and stuff like that - which just seems risky and - you know. They tell me it's very stimulating for the mind and body. Great. Sometimes those people are very lean. Oftentimes, they're not. And they're getting a lot of cold exposure. And one of the things that happens is if you expose yourself to cold over and over, you adapt. You become cold-adapted. And when you do that, you no longer get the epinephrine, the adrenaline release from the cold. And therefore, you don't get the succinate release and the shivering and the brown fat thermogenic effect quite as intensely. So, if you want to use cold for other reasons - and certainly cold water swims can be fun and there's - you know - as long as you can do them safely, they're - they're great. I've done - I've gotten into cold water swimming for some period of time. You can use cold for resilience, etc. But if you want to use cold to increase fat loss, then getting this shiver process going - the cooling and rewarming - which accelerates the amount of - or increases the amount of shiver. That's going to be the way to go.

Irisin

One note about cold and some of the factors that it releases. A few years back, there was a lot of excitement about this hormone called irisin - I-R-I-S-I-N - which was associated with cold. And

there was a lot of excitement about its potential role in increasing metabolism - so much so that people were starting to explore this as a potential fat loss drug. To my knowledge, that went nowhere. The science eventually shifted over to succinate as the main factor in cold-induced thermogenesis through this brown fat pathway. But if anyone out there is aware of any positive effects of irisin or you know of any science of irisin that I - I'm overlooking here or that I'm speaking about incorrectly, please let me know. I'd be very curious to learn.

Brown Fat / Why Babies Can't Shiver

Now, I want to just talk about brown fat a little bit more and talk about a period in your life in which you were rich with brown fat - you had a ton of brown fat. And that's when you were a baby. Babies can't shiver. These neurons that release epinephrine into fat are not wired up and really aren't present at sufficient levels or in sufficient numbers when you are a baby. And therefore, you can't shiver as a baby and you can't warm yourself up in cold environments very well. To compensate for that, Mother Nature installed in all of us an excess of brown fat early in life that exists, again, in the upper back, and the middle of the back, and the back of the neck.

Over time, if we don't expose ourselves to cold environments or do other things that make us shiver, we lose a lot of that brown fat. But what's interesting about brown fat is that there's some evidence that brown fat, just like white fat, can both increase in size - but that you can also add new cells. Now, this is a little bit controversial. People always say, "You can't change the number of fat cells. You can just shrink them or increase their size." Well, it turns out that epinephrine released from these little nerve endings in brown fat and succinate circulating in the body may - and I want to underscore "may" - have the effect of increasing the amount of brown fat cells probably by converting these beige fat cells into brown fat. So, that allows us to become much as we were early in life where we metabolized like crazy and we'd heat ourselves up without shivering.

Ice On Back of The Neck / Cold Underpants

Some people have taken the cold thing to the extreme - you know - putting ice packs on the back of their neck throughout the day. Did episode all about testosterone and estrogen. And there's this - let's just call it a - a very niche - I - I - I have to imagine very, very niche culture of people who are wearing literally - I'm not joking - they are these cool pack / ice pack underpants. They go by a name that I'm not going to repeat on here, but you can find them on Amazon. That's - those are people that are using cold packs on the body and on the groin to try and increase things like testosterone. But as well to try and increase thermogenesis and trying to increase their metabolism.
Just remember, if you become cold-adapted, you're not going to get the fat-burning effects to the same degree. So, cold is a powerful tool for fat loss, but you don't want to adapt. This is reminiscent of a rule that you hear about in endurance exercise - and in strength exercise as well - which is that you want to use the minimal effective stimulus to promote growth or progress - so, growth of the muscle or improvements in endurance. If you go 10% further on a run or - you know - 10% faster, you will likely see an improvement in performance - provided you recover - the next time you come back and do that same round of exercise. You'll be able to do more work, or complete the work more easily, etc. You've adapted.

If you do 20% more distance or 20% more weight, you won't necessarily see the same commiserate level of gain or improvement. And so likewise with cold - if you're quickly moving from 30 seconds of exposure to 10 minutes of exposure, you're overlooking the opportunity to get the most fat loss and increase in metabolism by stepping it up in smaller increments, okay? And this also speaks to the rationale for using cold exposure to accelerate fat loss for certain periods. But then, maybe not doing it year round if fat loss is your goal. Maybe use it for 2-3 months at a time. And then, stop for 2-3 months at a time because it is such a potent stimulus provided you engage in the shiver - in the shiver.

Research - Bartness et al.

Next, I'd like to move to exercise and how particular timing and types of exercise can vastly improve fat loss. Before I do that, I just want to mention a really important reference for those of you that are interested in learning more about how neurons connect to fat. This is certainly a paper that you'd want to look at if you're interested in diving deep into the literature and reading all the various studies. It's a review. And the title of the review is "Neural innervation of white adipose tissue and the control of lipolysis". That's "Neural innervation of white adipose tissue and the control of lipolysis". It was published in Frontiers in Neuroendocrinology. You can find that free online. They have the full text available. The first author is Bartness - B-A-R-T-N-E-S-S. It's a great review and I've talked about a number of things that are mentioned in the review. Follow the references in that review - and the reference trail, as we say - if you're interested in learning more about also how neurons control brown fat.

Spot Reduction

And before I move to exercise, I also just want to highlight something that comes up every few years and has largely been considered myth now, but that is actually more interesting than most people might think - which is this issue of spot reduction. You know, in the '80s and '90s, there was - there were a lot of commercials - late night infomercials - where they would talk about spot reduction. You know, if you do sit-ups, will - will you lose abdominal fat? If you do hip raises or glute raises, will you lose glute and hip fat? And I think everybody now believes and understands that fat metabolism is something that happens systemically throughout the body. That some body fat is quote-unquote "more stubborn" than others. Everyone varies in where they tend to store fat or lose fat last. A number of factors that influence that - and in particular, hormone receptors. But now - at least in the scientific literature - spot reduction and the possibility of real true spot reduction - reductions in fat in a targeted way - a - a body part or body area targeted way - is becoming more of a reality and may be a reality soon. Because exercise that triggers the activation of these nerve fibers - these neurons that innervate fat - in theory, if you can increase the amount of epinephrine released at those particular fat pads, as they're called - they're actually called fat pads in the scientific literature - in theory, you could increase mobilization from those particular body fat sites, okay? So, because the new view - the - the modern understanding is that it's not adrenaline released systemically - kind of - bathing all your fat tissue. But rather, it's neurons releasing adrenaline/epinephrine locally - that in theory, exercise that stimulates the release of epinephrine - or exercise coupled with things like shiver, or low-grade shaking movement, or these - the NEAT -

the - the non-exercise activity thermogenesis - could in theory lead to local enhancement of mobilization of fat tissue. So, I think that spot reduction actually will soon be something that's possible using the appropriate technology.

What does this mean for you now? What could - what could you possibly do for this - with this information now? Well, I think it speaks to the - the fact that if one is going to engage in exercise, that doing exercise that involve lots of different body parts and movements is likely to encourage the maintenance and/or growth of these neurons that innervate fat throughout the body. What this means is changing up the pattern of exercise - engaging in novel types of movements - may actually be one way that one can access these so-called "stubborn body fat pads". Now, there's a little bit of speculation in the statement that I'm making. But if you think about it, it makes sense. If you become very adapted to a particular pattern of exercise - whether or not you're sub-caloric or not - you're on maintenance calories or not - you are oxidizing some fat, always. And you're utilizing the neurons that innervate fat in a regular way. And pretty soon, this innervation is going to shut off because there's no reason why this neural innervation of fat should continue to release epinephrine unless you give it a strong stimulus like cold or the fidgeting - or in this case, to do novel forms of exercise. And there's some anecdotal evidence. And there, I don't even want to call it data - but anecdotal evidence that people who have quote-unquote "stubborn body fat" - if they start to adopt new patterns of exercise, they can start to access those stubborn fat pads. And again, "fat pads" is the correct way to refer to these in the scientific literature.

Exercise

So, what we're focusing on today is the fact that fat, indeed, will be mobilized and oxidized in response to a deficit in calories. But that the way that neurons control those fat pads and those body fat stores affords you a lot more control than perhaps you ever previously thought. So, let's talk about movement and the more traditional kinds of movement - a.k.a. exercise - has been shown to lead to increases in metabolism and fat loss to greater degrees depending on whether or not, for instance, you're fasted when you do it or not - whether or not you do your cardio first or your resistance training first. And this is, again, a literature for which there's a lot of controversy. But in digging through all the studies on - on this, we're finally starting to arrive at a consensus of when is best to do exercise and what types of exercise to do if your goal is fat loss.

The topic of exercise is a - kind of - controversial one. Not as controversial as nutrition and diet, which we will talk about in a few minutes. But it's a particularly interesting one because different types of exercise engage the musculature of the body, and the heart, and the lungs in different ways and can have vastly different effects on things like hormones and metabolism depending on whether or not it's of high intensity, modern intensity, or low intensity. So, rather than think about weight training versus cardiovascular exercise, I think the most simple way - the most fluid way - to have this conversation about exercise and fat loss is in terms of three general types of training. Whether or not it's done with weights or bodyweight doesn't really matter. And those are high-intensity interval training - something that seems to have gained a lot of popularity in recent years - so called HIIT - H-I-I-T. So, high-intensity interval training, sprint-interval training - so, that's

going to be very high intensity - or S-I-T - or moderate-intensity continuous training - M-I-C-T. So, we've got HIIT, SIT, and MICT - M-I-C-T.

SIT

And we can get a little bit more precise if you'd like. I'm not somebody who measures my VO2 max or anything while I exercise. I generally know whether or not I'm doing something I could continue for a very long time or whether or not I'm doing something that I realize is going to be of short duration - high intensity. But if you'd like to map this to VO2 max, SIT - this sprint-interval training - was defined as all out - greater than 100% of VO2 max bursts of activivity that last 8 to 30 seconds interspersed with less intense recovery periods. So, this would be sprinting down field for 8 to 30 seconds. Then, maybe walking back for about a minute of two. And then, sprinting again and then continuing. So, that would be SIT.

HIIT

HIIT - H-I-I-T - is defined as submaximal - so, 80 to 100% of VO2 max bursts of activity that last 60 - 240 seconds interspersed with less intense recovery periods. So, on a standard 400-meter track - just to give this a little bit of a visual - one - a 4-minute mile would be fantistic for most people - although, people run faster than that, of course. So, that's four 60-second laps, but that's back-to-back-to-back. I think in my - you know - in my best shape or maybe it was in my dreams - I don't recall which - I was able to get 60 seconds around the track. But of course, I couldn't get that on the second, or third, or fourth. If I did, that was certainly in fantasy land and not in reality. But 60 seconds would be about one revolution around the track - maybe - maybe 90 seconds depending on how fast one is running. So, 60 to 240 seconds.

MICT

MICT, okay? This moderate-intensity continuous training is steady-state cardio - sometimes called zone 2 cardio these days on the internet - which is performed continuously for 20 to 60 minutes at moderate intensity of 40 to 60% of VO2 max - or if you prefer heart rate, 55 to 70% of max heart rate, okay? So, we can think about high, medium, and low-intensity exercise. Although, low intensity usually means that you can carry on a conversation - or maybe you have to gasp every - every few steps or so while trying to talk and run. That's, I think, going to be the most useful way to have this conversation that we're having now because there's so many different forms of exercise that people do. And intensity is important.

Exercising Fasted

Let's ask the question that I think many of people are wondering about which is: Is it better - meaning do you burn more fat - if you do your exercise fasted? And fasted in this respect could be that you wake up in the morning. You've been fasting all night. You just hydrate and you exercise. Or sometimes, people will ingest caffeine. There's controversy as to whether or not that quote-unquote "breaks the fast". It has to do with whether or not your caffeine-adapted - something for another episode. In any case, that would be fasted. So, probably not having eaten anything for anywhere from 3 to 24 hours - or maybe even more as you could also be fasted in the

afternoon. If you had lunch at noon and it's 4, or 5, or 6pm - is it - will you burn more fat if you exercise without eating anything first - without ingesting any calories first?

And people have tried to really split hairs on this every which way. People say, "Well, you can fat fast because fat and protein doesn't lead to as great increases in insulin as other things. Maybe you can have a few almonds and then still train." And indeed, insulin will prevent fat oxidation. I want to be really clear. The burning part of fat in the cell - the - the movement of the fatty acid and it to mitochondria and the conversion to ATP - insulin inhibits that process. However, it's been shown that - at least, for short periods of training - it doesn't really seem to matter whether or not you eat before training or you don't if your goal is fat oxidation. Now, I want to put a asterisk near that because there are some exceptions.

But there were several studies done that - and the - kind of - the classic ones of these I'll - I'll read out to you. They - what they basically did is they gave people glucose/sugar to increase their blood sugar before training or not. And the - kind of - classic study of this is Ahlborg et al. So in 1976 - so, it goes way back - which is that glucose reduces fat burning and exercise. And then, some other - other studies. If you want to look these up, they're very easy to find on PubMed. You put in "Horowitz, 1999". Lee - Lee et al. - is another one where they have people drink milk with glucose in it - so, sweet sugary milk - before exercise, etc. And you can find a number of examples where eating before exercise reduces the amount of fat that's oxidized during the exercise. And you can also find a lot of studies showing that eating during exercise will - or prior to exercise - will not reduce the amount of fat that's oxidized. However, the types of exercise - whether or not it was medium intensity, or high intensity, or low intensity - is all over the map for these studies. So, it's very hard to target an ideal protocol.

90-Minute Rule

And then, if you look really deep in the literature, you start to find meta-analyses where people have actually aggregated all the findings and some modern studies where it points to some very specific and useful protocols. And so, here's the rule that - or the protocol that I extracted from that literature. At a period of about 90 minutes of moderate-intensity exercise - I want to be clear - after - at about or after 90 minutes of moderate-intensity exercise, there's a switchover point whereby if you ate before the exercise, you will reduce - excuse me, you will burn - far less fat from the 90-minute point onward than you would if you had gone into the training fasted. So, let me repeat that. If it's moderate intensity - so-called zone-2-cardio-type exercise - at the 90-minute point, if you happen to have eaten before the exercise - within 1 to 3 hours prior to the exercise - then you reduce the amount of fat that you will burn from 90 minutes onward. Whereas if you had fasted prior to the exercise - you hadn't eaten anything for 3 hours or more prior to the exercise - at the 90-minute point, you will - 90 minutes of exercise - you will start to burn more fat than you would had you eaten. Now, 90 minutes of moderate-intensity exercise is a lot. So, that's a - that's a pretty long run. Even if you're running at a pretty slow pace - like a 10 or 12 minute mile - that's a lot of running. That's a lot of swimming. So, that's a lot of walking. That's a lot of hiking. However, there

are people who are going out hiking all day, or running all day, or walking all day. And if you want to burn more fat per unit time - you want to oxidize more fat - then you would do that fasted.

Now, there are also studies that point to the fact that you don't have to wait to 90 minutes in order to get this enhanced fat-burning effect. The studies I was able to find and that looked to me like quality peer-reviewed studies with no company bias or no product bias of any kind - these are studies that were largely funded by the federal government in the university context - pointed to the fact that if one does high-intensity training or - or even the very-high-intensity forms of training like sprints, or squats, or deadlifts, or any kind of activity that can't be maintained for more than these - you know - 8 - or I would say up to 60 seconds. So, a set of lifting weights - repeated - repeated. If that's done for anywhere from 20 minutes - so, weight training, or powerlifting, or these kinds of things, or kettlebell swings - or up to 60 minutes - well then, the switchover point in which you can burn more fat, if you go into that fasted, comes earlier.

And this makes sense because there's nothing holy about the 90-minute point for medium-intensity zone 2 cardio. That 90-minute point is the point in which the body shifts over from mainly burning glycogen - basically sugar that comes from muscles or the liver - and realizes, "This is going on for a while. I'm going to shift over to a storage-site fuel that is in reserve like body fat. It's - this is going to happen for a while, so I'm going to start tapping into body fat stores." Now, fat doesn't have a little brain there. It is innervated by neurons, but it doesn't have thoughts. And you don't actually control this switch with your mind. This is something that has to do with the milieu of various hormones. What has to happen is insulin has to go down far enough. So, if you ate before the exercise, you'd have an increase in insulin. If you ate carbohydrates, you'd have a bigger increase in insulin. Fat and proteins, indeed, will have lower amounts of insulin. And fasting will give you the lowest amount of insulin. Well then, that switchover point is going to come earlier in the exercise. And if you think about it - if you were to do something high intensity for 20, 30, 40 minutes - so, maybe lift weights - and then get into zone 2 cardio - if you were fasted, the literature says that you're going to burn more body fat per unit time than if you had eaten before or during the exercise. So, what does this mean? This means if you want to burn more body fat - if it's in your protocols and you're - you know - have been approved to do this safely - exercise intensely for 20 to 60 minutes - the higher the intensity, obviously the shorter that bout is going to be - and then, move over into zone 2 cardio. And if you do that fasted - or the medium-intensity cardio, I should say - and if you do that fasted, then indeed you will burn a higher percentage of body fat.

If you need to eat or you like to eat before you train, that also can work. And if you train very intensely, you're likely to shift over to the fat-burning pattern more quickly as well. So again, this isn't really an issue of how long you exercise. It's an issue of how intensely you exercise and therefore what fuel source you're drawing from. So, hopefully I've made that clear. But basically you need to deplete glycogen or - through high-intensity exercise - and then, move to a steady-state exercise that will allow you to burn more fat. Or you need to perform a medium-intensity or low-intensity-type exercise for a long period of time before you shift over to burning fat. And indeed, it seems that going into all that fasted will facilitate the burning of more fat overall. But if

you can't even get to the exercise - if you're somebody who just can't do the training at all - you're unwilling to or you're incapable of training unless you eat something - then obviously, eating something makes the most sense. And what you eat prior to exercise, that's a whole other biz that people argue about and fight about - whether or not you should go into it with low carbohydrates or higher carbohydrates - all of that. But in general, the theme there is very simple - which is that you want insulin levels to be pretty low if your goal is body fat reduction - if you want to oxidize body fat. So, fasting in some cases - fat fasting in other cases where you're just ingesting fats - fat and protein in some cases - or for some people, it will be eating carbohydrates. I'm not here to dictate a particular nutrition regimen. That's just how the hormone balance of these things and fat oxidation works.

Post-Exercise Metabolic Increase

Now, one thing that's very interesting and cannot be overlooked is this issue of how much energy you burn during and after the activity. And some of you probably already know about this, but the whole business of calories in versus calories out and people counting their - the number of calories they burn during their aerobic session or during their whatever session is only one half of the equation and it really eclipses the more important issue - which is: How much of an increase in metabolism does a given exercise create after the exercise? And we could talk for hours about this, but the simple way to view this is that high-intensity training - anaerobic training of weight training, sprints, burpees - any kind of thing. I don't know. These days I see - I hear you're not supposed to do burpees - that people think burpees are dangerous. So, I'm not suggesting in particular movements here. You have to decide what's right for you. I do burpees. I don't - I don't seem to be injured from them, but I hear that they're terrible for some people. So anyway - push up, sit ups - whatever happens to be that anaerobic exercise that's of higher intensity - or sprints - taps into glycogen stores during the movement and will burn more energy per unit time than moderate intensity. High intensity burns higher than moderate intensity. That's straightforward.

What's interesting is that all the studies that I was able to find on what happens after that type of exercise showed that the percentage of fat that you burn after high-intensity exercise is actually greater. In other words, you burn a lot of glycogen during the high-intensity exercise. And then after the exercise, the post-exercise oxygen consumption - as it's sometimes called - goes up. We know this. After you train intensely, that post-exercise oxygen consumption goes up. Sometimes for up to 24 hours. And it is during that period of time that you oxidize more fat - not glycogen.

Now, what's interesting is that the reverse is also true for people that do long bouts of low or moderate-intensity exercise. So typically, this would be things like running, swimming, biking, etc. So, 60/90 minutes/2 hours - maybe even people that are training for marathons or half-marathons. When they stop training, they burn more glycogen - more carbohydrate - even though they were burning more body fat per unit time during the low-intensity exercise. So, there's this kind of inversion. High intensity burns more glycogen during the activity - more body fat afterwards. Moderate to low intensity burns more percentage-wise - more body fat is oxidized than glycogen during the move - during the actual exercise. Afterward, it's more glycogen.

So, I don't want this to get too complicated. The point is you should pick exercise that you like - that you're going to do regularly. But it does seem that the high-intensity exercise, followed by moderate-intensity exercise, is going to be optimal for fat burning overall. Because when you look at the percentage of body fat burned and you look at the overall increase in basal metabolic rate, moderate and high-intensity training followed by low-intensity training - or even just followed by going back into life - is going to be the best way to continue to burn body fat because of the ways that it increases basal metabolic rate.

Protocol For Exercise-Induced Fat Loss

This could be distilled into a simple protocol whereby 3 or 4 times a week, you do high-intensity training, followed by either nothing or followed by low-intensity training - especially if you're able to do that fasted. And I should just mention that none of this stuff about fasted is about performance. If you want to perform really well - you want to - you're - this is for reasons of performance and you want to - you know - it's for a sport or a competition - it's not for body fat purposes - well then, all of this kind of falls away and is modified by what's ideal to eat for performance. But what we're talking about today is how to optimize body fat - body fat loss. So, train moderately to intensely - to very high intensity. And then, moderate to low intensity. Or train moderate to high intensity and then go about life.

And in fact, I have a friend who uses this strategy. He likes the train intensely and not that often protocol because he's a very busy person. So, he'll train for 20 to 30 minutes intensely with weights or just body-weight movement - doing a lot of - he does burpees, and push-ups, and sit-ups, and pull-ups, and just kind of moving, and kind of "circuit-type training". But where he's breathing really hard. The goal he always says is, "I want to breathe hard for 30 minutes every day." And then afterwards, he hydrates and drinks coffee and moves into his day. And he's walking around, and taking calls, and carrying around his children, and doing all these kinds of things that keep him really busy. But it's kind of like low-intensity work. So, I think you get the principle now.

Adrenaline / Epinephrine

But you should all be asking yourselves - as scientists of yourselves: Why would it be that certain patterns of exercise would lead to more or less fat loss? I mean - it can't just be about the energy burned. We have already established that. And again, it has to do with the neurons. It has to do with how we engage the nervous system. So, while non-exercise activity induced thermogenesis - NEAT - the fidgeting and cold - can induce thermogenesis by engaging shiver-type movement or low-level movements. Big movements that are of very high intensity - meaning they require a lot of effort - deploy a lot of adrenaline/epinephrine from our neurons and signal particular types and amounts of fat thermogenesis - fat oxidation. Whereas low-level-intensity exercise - low or moderate-intensity exercise - you know - walking, running, biking - where you can do that easily - there's not very much adrenaline release. So, adrenaline - and a.k.a. epinephrine - is really the final common path by which movement of any kind - whether or not it's low-level shiver - or whether or not it's lifting a barbell, sprinting up a hill, or doing a long bike ride - adrenaline is the effector of fat loss. It's the trigger and it's the effector.

Tool – Caffeine

So, now I want to turn our attention to compounds that increase epinephrine and adrenaline - as well as compounds that work outside the - the adrenaline/epinephrine pathway to increase the rates of fat loss. I almost always save compounds, and supplements, and - and things of that sort to the end because I do believe that people should look first toward behavioral tools and an understanding of the science before they look toward a supplement or a particular thing that's going to be a little bit different. So, I think that's a particular thing that they can extract from diet. This is mainly to try and shift people away from the - kind of - magic pill phenomenon or the - the idea that there is a magic pill because there really isn't. And frankly, there never will be. But there are some compounds that can greatly increase fat oxidation and mobilization. And understanding which compounds increase oxidation or mobilization can be very useful if your goal is to accelerate fat loss. There are things that people can ingest that will allow them to oxidize more fat. And that occurs mainly by increasing the amount of epinephrine that is released from neurons that innervate fat tissue.

One of the more common ones is one that you may already be using - which is caffeine. It's well established that caffeine can enhance performance if you're caffeine-adapted. I talked about this in an earlier episode, so I want to make sure I'm very clear about this. If you are not used to drinking caffeine and you suddenly decide I'm going to drink a big cup of coffee before training, you will vasoconstrict and you will limit performance. So, that's performance. If you're caffeine-adapted, however, there's this kind of interesting phenomenon where ingestion of caffeine serves more as a performance enhancer - both by increasing alertness, but also by way of dilating vasculature - of allowing more blood flow.

Now, caffeine for burning more fat - for oxidizing and mobilizing more fat - is an interesting one. It can be effective at dosages up to 400 milligrams. You have to be careful if you're caffeine-sensitive. Some people have just the littlest bit of caffeine and their mind goes crazy. And they're very uncomfortable. It can have cardiovascular effects for some people with hypertension, etc. So, please check with your doctor. But 400 milligrams is roughly a cup and a half of coffee - or two cups of coffee. Nowadays, there's a lot more caffeine in coffee. So, if you go to a typical café and you were to get their medium size, that would have close to a gram of caffeine - which is why if you're a regular caffeine consumer and you don't get that gram of caffeine in your coffee each day, you will get a headache. It can cause constriction and dilation of blood vessels in ways that's complicated, but you'll get a headache. Some people like the way they feel drinking 100 to 200 - 300 - maybe even 400 - milligrams of caffeine before training. And indeed, that will lead to increased fat oxidation. It will do that because you will release more epinephrine and adrenaline.

So, let's just place this in the context of what we said previously. Let's say you normally do zone 2 cardio. So, you're going out for a moderately intense run for 30 to 60 minutes or so. I think the current recommendation guidelines in the States are that people engage in 30 minutes of moderate-intensity exercise 5 days a week for - so, that's 150 minutes - if their goal is to improve or maintain health of the cardiovascular system. 80% of people in the United States fail to do that or

anything close to it. They're - we are way below threshold for what the government has recommended. In this case, the government recommendations, I think, are pretty good. That's - one could always do better, of course. But 80% of people aren't even doing that.

However, just using the logic and the understanding of how epinephrine/adrenaline is - is affecting this fat oxidation process - if you were to go out for 15 minutes and you drank caffeine before you went - yes, you'll probably oxidize more fat per unit time. Can you compensate for the exercise you're not doing just by drinking caffeine? Well, probably - if you were just talking about fat loss - if that caffeine makes you fidget a lot, right? The amount of calories that you burn in a 30-minute run - unless the run is very intense, and you're wearing a weight vest, and it's up a hill - it's not that great, right? You probably get - you know - somewhere into the 400-500 calories burned area. But I said earlier - and there are a lot of data now that support that fidgeting for a day can burn anywhere from 800 to 2,500 calories a day. So, you might say, "Well, fidgeting is better than running." Ah, but it doesn't trigger the activation and the positive health effects of the cardiovascular system. So, fidgeting alone can be great, but you need exercise for other reasons.

Caffeine can enhance the amount of fat that you burn in any duration of exercise and it can shift the percentage of fat that you oxidize compared to glycogen - unless you take that caffeine and it ramps you up so much that you're training really, really intensely. The bottom line is - if you like caffeine and you can use it safely, ingesting somewhere between 100 and 400 milligrams of caffeine prior to exercise - somewhere between 30 to 40 minutes before exercise - can be beneficial if we're talking about fat oxidation - burning more body fat. So that's caffeine.

Ephedrine / Fenfluramine

There are a number of other things that have existed over the years that are in this pathway. Things like ephedrine - which is now illegal in most states - I think maybe in all states - because people were dropping dead from taking ephedrine because they were heating up too much. It's interesting. There - it wasn't direct effects on the heart causing heart attack. It could trigger - by way of adrenergic receptors, if you'd like to know - increases in body temperature and heat. Now, there - those drugs turned out to be dangerous because people were overheating and dying. There was also the big Fen-Fen craze. There was a drug that was released - fenfluramine - which actually was quite effective as an anti-obesity drug - a treatment for obesity. That had to be outlawed as well. It was - it was - its FDA approval was removed because, again, people were dying because of cardiovascular effects. I don't know if people were overheating on it as well. So, what is the solution? If caffeine is the - kind of - the entry point for most people of using compounds to increase the rate or percentage of fat loss in exercise and even at rest, what are some of the other things that are - are useful and interesting?

Tool - GLP-1 / Maté / Guayusa / Semaglutide

Well, in terms of tools that are actionable and have reasonable safety margins - I've talked before about something called GLP-1. This is something that can be triggered by the ingestion of yerba maté - which is a tea. I guess because I'm half-Argentine, that I grew up drinking maté. I think I was

drinking maté from the time I was about 3 or 4 years old. I don't suggest that for kids. I don't think kids should be ingesting caffeine. But anyway, I did it. And I still ingest maté. Maté increases GLP-1. GLP-1 is in the glucagon pathway. So, let's just quickly return to our biochemistry. As you recall, fat is mobilized from body fat stores. And then, it's burned up. It's oxidized in cells. It actually needs to be converted into ATP. And those fatty acids are essentially converted into ATP in the mitochondria of the cell. High insulin prevents that from happening. And glucagon facilitates that process. Glucagon facilitates that process through increases in GLP-1. The short takeaway is maté increases GLP-1. And yes, increases the percentage of fat that you'll burn. It increases fat burning. And that is especially true, it turns out from the scientific literature, if you ingest maté prior to exercise of any kind. So, if you want to burn more fat, drinking maté before exercise is good. Drinking it at rest - when you're not exercising - will also help shift your metabolism toward enhanced burning of fat by increasing fat oxidation.

Now, there's a whole category of pharmaceuticals that's being developed right now that are in late-stage trials or are in use for the treatment of diabetes - which capitalize on this GLP-1 pathway. They go by various names and there are people on the internet who are selling these things. They are prescription drugs. And I want to emphasize that they are prescription drugs. And you obviously wouldn't want to use any of these without a prescription and a requirement. They - it does seem that they are effective for the treatment of certain kinds of diabetes and lead to fairly significant weight loss and reduction in appetite. So, this is kind of the modern version of GLP-1 is - pharmaceuticals of GLP-1 metabolism are drugs such as semaglutide. I can never pronounce this. I can't seem to pronounce many things. Semaglutide is the way I would pronounce it. S-E-M-A-G-L-U-T-I-D-E - semaglutide. But that's not the way you pronounce it. But semaglutide is the way that it's been described on the internet. In any case, this compound increases GLP-1. It's actually a GLP-1 analog in some cases. And they go by various types of - of trade names. So, the GLP-1 pathway is interesting.

Most people, including myself, are not interested in taking a prescription drug to increase GLP-1. I do it through the ingestion of maté. I just get the maté leaves, pour water over it, and drink it. What's kind of interesting - that's not often discussed - is that you can increase the amount of GLP-1 by - you can essentially reuse the tea. The - the first time you drink it, it's going to be very, very intense. In fact, some people find that maté almost tastes like burnt leaves. It's too intense. You don't want the water to be too hot. But I learned this trick from a friend. You can reuse the leaves over and over again - probably for about a day before they go bad. And in doing that, you start to extract more and more of the compounds from the maté leaf that increase GLP-1. So, it's kind of cool. You can kind of get an increased effect. So, what I'll typically do is make a - a - a - a - about 16 to 30 ounces of it and just sip it throughout the day. And I do like it before I train.

Some people who don't like maté might prefer something like guayusa - which is spelled G-U-A-Y-U-S-A - G-U-A-Y-U-S-A - guayusa - which is from Ecuador. Despite the U-S-A ending to it, it's from Ecuador. And it's a - it's a sweeter tasting tea. It doesn't have any sweetener in it, but the leaf of the guayusa plant is sweeter than the maté plant. I sometimes will mix the two and then

make the tea with that. There - there's no maté or guayusa sponsor of the podcast. These are just tools to increase GLP-1 and fat oxidation. And again, the semaglutide is the prescription version where - of the - this - kind of - the heavy artillery GLP-1 stimulant. And again, should be only explored with a prescription. So, those are the compounds that really increase fat oxidation directly.

Tool - Glucose/Insulin Reduction, Berberine & Metformin

There are going to be a number of things that impact insulin and glucagon that are going to shift the body toward more fat burning. We talked about a lot of these during the episode on hormones. We talked about it. We did a whole episode on hormones and metabolism. And so, for instance, berberine - which comes from a plant - or metformin are compounds that are now in - kind of - growing use for reducing blood glucose. They are very potent at reducing blood glucose, which will reduce insulin - because the job of the hormone insulin is to essentially manage glucose in the bloodstream. So, there are a huge gallery of compounds that will reduce insulin and thereby can increase fat oxidation. And that's because, as I mentioned before, fat oxidation - this conversion of fatty acids into ATP in the mitochondria - is inhibited by insulin. So, if you keep insulin low, you're going to increase that process.

Diet / Adherence

Which brings us full circle back to the issue of diet and nutrition. There is really solid evidence from the Gardner lab at Stanford and from other labs showing that when you look at different diets - you look at low-fat diets, high-fat diets, keto diets, intermittent fasting - provided people stick to their particular diet, it doesn't really matter which diet you follow. You can still get a caloric deficit and you get weight loss. Adherence, however, is always an issue. And so, what I always say is that you want to use the eating plan that is obviously beneficial to your health - but the one that allows you to adhere to whatever it is that the particular nutrition protocol is, right? If you can't stick with something, then it's not very worthwhile.

But from the purely scientific standpoint, there's also an advantage to keeping insulin low. Now, that doesn't necessarily mean you go to zero carbohydrate. I've talked before about - my preferred way of eating is to go low or no carbohydrate throughout the day for alertness - to get that adrenaline release, and the focus that goes with it, etc. - and the ability to think, and move, and do all the things I need to do during the day. And then, I eat carbohydrates at night because it facilitates the transition to sleep. That's what works for me. But when insulin is low, you do place your system in a position to oxidize more fat. And so, that's why I think a lot of people do see benefit from lower-carbohydrate or moderate-carbohydrate diets - because when insulin is low, you're in a position to oxidize more fat - both from exercise and at rest.

Examine.com

And I should mention - because I often mention and it's appropriate to mention - that if you're interested in looking at the effects of caffeine, of maté, guayusa, things of that sort, GLP-1 - you want to learn more about those - you can go to this wonderful website - which is free -

examine.com. You can put in "yerba maté". It will describe the three studies that show increased fat oxidation - both during exercise and at rest. And it, as a consequence - not surprisingly - an increase in metabolic rate. One thing that's interesting about maté is it causes a slight decrease in heart rate for reasons that still escape me. There's a single study showing that heart rate is slightly reduced, which is kind of nice because if - when I drink too much caffeine, my heart rate goes up. Maybe that would increase my fidgeting and my fat burning. But I don't like the feeling of having my basal heart rate being up too high. I like my heart rate elevated during exercise, but not when I'm just kind of resting or working and throughout the day. And for some reason that - that I don't understand, there's an effect of maté of increasing fat oxidation, but reducing heart rate just slightly. So, that's interesting and it probably lends itself to my - you know - explains the subjective experience that I've had of that maté is - kind of - a little nice even mellow stimulant. It's not - you know - this really supercharged stimulant like caffeine from coffee or other sources. Although if you drink too much maté, it will also make you jittery.

Tool - Acetyl-L-Carnitine

And there's one more compound that I think we should discuss in terms of increasing fat loss - and that's carnitine or acetyl-L-carnitine. They lie in the same pathway. We can return to our basic knowledge now of fat mobilization and oxidation. After fat is mobilized, and makes it into cells, and needs to be oxidized - so, the - literally the burning of fat and conversion of it into energy. That is accomplished and is facilitated by the presence of glucagon being elevated - GLP increases that process - and insulin being low. And we talked about some ways to manage insulin, both in this episode and in previous episode. L-carnitine - and acetyl-L-carnitine, in particular - facilitates fat oxidation. It converts - it helps convert fatty acids into ATP. And indeed, supplementing L-carnitine can increase fat loss. That's been shown. At what dosages? Well, people ingest anywhere from 500 milligrams to 2 grams per day - in divided doses, typically. Some people who are really extreme are taking injectable L-carnitine. I've certainly not tried that. I confess I have used it in pill form from time to time. But, in part, because of the fat oxidation effects - but also because of the other effects that it tends to have.

So, in exploring the effects that acetyl-L-carnitine has, it has a huge variety of effects on cellular metabolism. It can reduce ammonia in the blood. That is actually a - a quite strong effect. It can reduce things like c-reactive protein - which is - you want c-reactive protein levels to be managed. You do not want them too high. It can slightly reduce blood glucose. It can slightly increase HDLC - the good form of - of the blood lipid - and slightly reduce overall cholesterol. And as I mentioned, it can slightly modify the pathway involving glucagon such that you get a considerable effect - not a huge effect - on fat oxidation. So, it can improve fat oxidation rates. It has a number of other effects - some of which I talked about during the month on hormones - and that sort of thing. It has strong effects on rates of pregnancy and sperm quality. So clearly, carnitine is doing lots of different things in lots of different cells. It's impacting sperm motility. They're in a large number of studies supporting that. Slight reductions in blood pressure - and has these interesting effects on reducing fatigue during exercise - reducing inflammatory markers like interleukin-6. So, it has a number of effects that on the whole are quote-unquote "positive" - or at least, in the direction of

things that you may want - and I should emphasize "may". You certainly don't need acetyl-L-carnitine in order to lose fat. But now that you understand the cellular process by which fat is mobilized and oxidized, it should make sense that if L-carnitine is important for converting fatty acids into energy, then supplementing L-carnitine makes sense. Acetyl-L-carnitine is the type of L-carnitine - or the form of L-carnitine, I should say - that is transported and utilized most easily by the body. And so, that's why sometimes we distinguish between L-carnitine and acetyl-L-carnitine.

Conclusion

So once again, we've covered an enormous amount of material. We've talked about the science of fat loss. And in particular, we've explored this topic from the perspective of the nervous system - how neurons and in particular, the release of things like adrenaline/epinephrine can facilitate fat mobilization and oxidation. We talked about NEAT - fidgeting - this non-exercise-type movement that can greatly increase caloric burn and why that is. We talked about shiver - another form of non-exercise movement that can really increase both caloric expenditure due to the shiver - due to the movement - as well as increase thermogenesis - the heating up of the body through things like brown fat and even the conversion of white fat to brown fat - which is a good thing if you want to oxidize fat. We talked about cold as a particular stimulus to induce shiver and how to use getting into and out of cold as a way to stimulate shiver and avoid cold adaptation so that you continue to oxidize and burn fat - if that's your goal. If you want to check out the protocols for that, they're at thecoldplunge.com. And in weeks to come, we're going to be adding more protocols to that website - not just for fat loss, but for things like resilience, reducing inflammation, etc. So, be sure to check those out. Again, those are totally cost-free. We talked about exercise - how rather than thinking about cardiovascular or weight training exercise, that we should perhaps look through the lens of this adrenaline system and how it interacts with fat stores and think about low, medium, or high-intensity exercise - whether or not we show up to that fasted or not. Turns out showing up to that fasted can be useful if you start with high-intensity movements and then move into lower-intensity-type exercise. If you're going to go long duration, it probably doesn't matter unless you're exercising longer than 90 minutes whether or not you eat or not. We talked about caffeine as a stimulant and a stimulus for epinephrine and adrenaline release as a way to access more fat metabolism. And we talked about compounds that come from things like yerba maté and guayusa tea - this GLP-1 pathway - that can trigger increased fat oxidation - so much so that the pharmaceutical companies are now developing compounds specifically to increase GLP-1 for treatment of diabetes and obesity. But you can leverage the GLP-1 pathway through the ingestion of things like maté or guayusa if that's of interest to you. And then, we talked about L-carnitine and how L-carnitine itself is critical for the fat oxidation within individual cells - the conversion of fatty acids to energy - and why having your insulin low and things like L-carnitine and glucagon levels high - or sufficient, at least - to - can facilitate the burning of fat - fat oxidation. So we covered a lot of material. That's a lot of protocols I realize. And that didn't - the little list I just gave right there didn't even begin to get into all the details and corners that we discussed. I hope you found this conversation interesting - both for sake of understanding fat loss, and how to lose fat more quickly,

and to lose more of it - if that's your goal - as well as simply to understand the biology of fat metabolism from a different perspective - from the perspective of the nervous system.

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