Dr. Andy Galpin: How to Build Strength, Muscle Size & Endurance | Huberman Lab Podcast #65

My guest is Dr. Andy Galpin, Professor of Kinesiology at California State University, Fullerton, and one of the foremost experts in the world on the science and application of methods to increase strength, hypertrophy and endurance performance. We discuss fundamental principles of strength and hypertrophy training and building endurance, the mechanisms underlying them and we review specific protocols to optimize training and recovery. We also discuss hydration, sleep, nutrition, supplements, and mental tools that can be leveraged to accelerate adaptations leading to enhanced strength, muscle growth and/or endurance.

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- Welcome to the Huberman Lab Podcast, where we discuss science and science-based tools for everyday life. I'm Andrew Huberman, and I'm a professor of neurobiology and ophthalmology at Stanford School of Medicine. Today my guest is Dr. Andy Galpin. Dr. Galpin is a full and tenured professor in the department of kinesiology at California State University in Fullerton. He is also a world expert in all things exercise science and kinesiology. Today, you are going to hear what is essentially a masterclass in how to build fitness, no matter what level of fitness you happen to have. He talks about how to build endurance, and the multiple types of endurance. He talks about how to build strength and hypertrophy, which is the growth of muscle fibers. So if you're seeking to

get stronger, or build bigger muscles, or build endurance, or all of those things, today you're going to learn how. You're also going to learn how to build flexibility, how to hydrate properly for exercise. And we'll also talk about nutrition and supplementation. What makes Dr. Galpin so unique is his ability to span all levels of exercise science. He has the ability to clearly communicate the sets and repetition schemes that one would want to follow, for instance, to build more strength or to build larger muscles. He also clearly describes exactly how to train if you want to build more endurance, or enhance cardiovascular function. What's highly unique about Dr. Galpin and the information he teaches, and the way he communicates that information, is that he can take specific recommendations of how recreational exercisers, or even professional athletes ought to train for their specific goals, and link that to specific mechanisms. That is the specific changes that need to occur in the nervous system and in muscle fibers, and indeed right down to the genetics of individual cells in your brain and body, in order for those exercise adaptations to occur. It's truly rare to find somebody that can span so many different levels of analyses, and who is able to communicate all those levels of understanding in such a clear and actionable way. Indeed, Dr. Galpin is one of just a handful of people to which I and many others look when they want to make sure that the information that they're getting about exercise is gleaned from quality peer-reviewed studies, hands-on experience with a wide variety of research subjects, meaning everyday people all the way up to professional athletes in a wide variety of sports. So it's no surprise that he's not only one of the most knowledgeable, but also the most trusted voices in exercise science. Dr. Galpin is also an avid communicator of zero cost to consumer information about exercise science. You can find him on Instagram at Dr. Andy Galpin, and also on Twitter at Dr. Andy Galpin. Both places he provides terrific information about recent studies, both from his laboratory and from other laboratories, more in depth protocols of the sort that you'll hear about today. So if you're not already following him, be sure to do so. He provides only the best information. He's extremely nuanced and precise and clear in delivering that information. I'm certain that by the end of today's conversation, you'll come away with a tremendous amount of new knowledge

00:03:08 The Brain-Body Contract

that you can devote to your exercise pursuits. I'm pleased to announce that I'm hosting two live events this May. The first live event will be hosted in Seattle, Washington on

May 17th. The second live event will be hosted in Portland, Oregon on May 18th. Both are part of a lecture series entitled "The Brain Body Contract", during which I will discuss science and science-based tools for mental health, physical health, and performance. I should point out that while some of the material I'll cover will overlap with information covered here on the "Huberman Lab Podcast", and on various social media posts, most of the information I will cover is going to be distinct from information covered on the podcast or elsewhere. So once again, it's Seattle on May 17th, Portland on May 18th. You can access tickets by going to hubermanlab.com/tour.

00:03:55 AG1 (Athletic Greens), Thesis, InsideTracker

And I hope to see you there. Before we begin, I'd like to emphasize that 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 Athletic Greens. Athletic Greens is an all-in-one vitamin mineral probiotic drink. I've been taking Athletic Greens since 2012, so I'm delighted that they're sponsoring the podcast. The reason I started taking Athletic Greens and the reason I still take Athletic Greens once or twice a day, is that it helps me cover all of my basic nutritional needs. It makes up for any deficiencies that I might have. In addition, it has probiotics which are vital for microbiome health. I've done a couple of episodes now on the so-called gut microbiome and the ways in which the microbiome interacts with your immune system, with your brain, to regulate mood, and essentially with every biological system relevant to health throughout your brain and body. With Athletic Greens, I get the vitamins I need, the minerals I need, and the probiotics to support my microbiome. If you'd like to try Athletic Greens, you can go to athleticgreens.com/huberman, and claim a special offer. They'll give you five free travel packs, which make it easy to mix up Athletic Greens while you're on the road, plus a year's supply of vitamin D3 K2. There are a ton of data now showing that vitamin D3 is essential for various aspects of our brain and body health. Even if we're getting a lot of sunshine, many of us are still deficient in vitamin D3. And K2 is also important because it regulates things like cardiovascular function, calcium in the body, and so on. Again, go to athleticgreens.com/huberman to claim the special offer of the five free travel packs and the year's supply of vitamin D3 K2. Today's episode is also brought to us by Thesis.

Thesis makes what are called nootropics, which means smart drugs. Now, to be honest, I am not a fan of the term nootropics. I don't believe in smart drugs in the sense that I don't believe that there's any one substance or collection of substances that can make us smarter. I do believe, based on science however, that there are particular neural circuits and brain functions that allow us to be more focused, more alert, access creativity, be more motivated, et cetera. That's just the way that the brain works. Different neural circuits for different brain states. And so the idea of a nootropic that's just going to make us smarter all around, fails to acknowledge that smarter is many things, right? If you're an artist, you're a musician, you're doing math, you're doing accounting, a different part of the day you need to be creative, these are all different brain processes. Thesis understands this. And as far as I know, they're the first nootropics company to create targeted nootropics for specific outcomes. They only use the highest quality ingredients, which of course is essential. Some of those I've talked about on the podcast, things like DHA, Ginko biloba, phosphatidylserine. They give you the ability to try several different blends over the course of a month, discover which nootropics work best for your unique brain chemistry and genetics and goals, and with that personalization, design a kit of nootropics that's ideal for the different brain and body states you want to access. I've been using Thesis for more than six months now, and I can confidently say that their nootropics have been a total game-changer. My go-to formula is the clarity formula, or sometimes I'll use their energy formula before training. To get your own personalized nootropic starter kit, go online to takethesis.com/huberman, take a three minute quiz, and Thesis will send you four different formulas to try in your first month. That's takethesis.com/huberman, and use the code Huberman at checkout for 10% off your first order. Today's episode is also brought to us by Inside Tracker. Inside Tracker is a personalized nutrition platform that analyzes data from your blood and DNA, to help you better understand your body and help you reach your health goals. I've long been a believer in getting regular blood work done, for the simple reason that many of the factors that impact your immediate and long-term health can only be assessed with a quality blood test. What's unique about Inside Tracker is that while there are a lot of different tests out there for hormones and metabolic factors, et cetera, with Inside Tracker, you get the numbers back in terms of your levels, but they also give you very clear directives in terms of lifestyle, nutrition and supplementation, that can help you bring those values into the ranges that are best for you and your health goals. And that's very different than a lot of the other programs,

where you get a lot of information, but you don't really know what to do with that information. Inside Tracker makes that all very easy to understand and very actionable, based on the very easy to use dashboard at Inside Tracker. If you'd like to try Inside Tracker, you can visit insidetracker.com/huberman, to get 20% off any of Inside Tracker's plans.

00:08:20 Adaptations of Exercise, Progressive Overload

Just use the code Huberman at checkout. And now for my discussion with Dr. Andy Galpin. Welcome Dr. Professor Andy Galpin. It's been a long time coming. We have friends in common, but this is actually the first time we've sat down face-to-face. - Yeah, I'm very excited. - Yeah, there are only a handful, meaning about three or four people, who I trust enough in the exercise physiology space, that when they speak, I not only listen, but I modify my protocols, and you are among those three or four people. So first of all, a debt of gratitude, thank you. You've greatly shaped the protocols that I use. And I know there's far more for me and for others to learn. So you're a professor, you teach in university, and you have a tremendous range of levels of exploration. Muscle biopsy, literally images down the microscope, all the way to training professional athletes and everything in between. So you are truly an N-of-1. And just to start us off, I would love to have you share with us what you think most everybody, or even everybody should know, about principles of strength training, principles of endurance training, and principles of, let's call it hypertrophy power and the other sort of categories of training. And this could be very top contour. But what do you think everybody on planet Earth should know about these categories of personal and athletic development? - Well, that's a great first question. Holy cow! I think I'll start it this way. I tend to think about, there's about nine different adaptations you can get from exercise. Fat loss is not one of those. It is a byproduct. But that's not really what I'm getting at. And so we can kind of categorize everything like that. And what we're going to, we can talk about, or what are the concepts that you need to hit within each one. And then you could have infinite discussion of the different methodologies, right? And so that first thing to hit is the concepts are actually fairly few, but the methods are many, right? People have said that in iterations throughout time. So if you walk from the very beginning, the first one to think about is what we'll just call skill. So this is improving anything from say a golf swing, to a squatting technique, to running. And this is just simply moving mechanically, how you

want your body to move. I'm just going to globally call that skill. From there, we're going to get into speed. So this is moving as fast as possible. The next one is power, and power is a function of speed, but it is also a function of the next one, which is strength. So if you actually multiply strength by speed, you get power. And the reason I'm making this distinction by the way is, some of these are very close, and I'm going in a specific order on purpose here. For example, power is, like I just said, it's a function of speed and strength. So if you improve speed, you've also likely improved power. But not necessarily, right, 'cause it could've come from the force direction either. So there's carryover, so like a lot of things that you would do for the development of strength and power, they are somewhat similar, but then there's differences, right? So things that you would do correctly for power would really not develop much strength, and vice versa. So we can get into all these details later. Once you get past strength, and the next one kind of down the list is hypertrophy, this is muscle size, right? Growing muscle mass is one way to think about it. After hypertrophy, you get into these categories of, the next one is, these are all globally endurance-based issues. And the very first one is called muscular endurance. So this is your ability to do how many pushups can you do in one minute? You know, things like that. Past muscular endurance, you're now into more of an energetic or even cardiovascular fatigue. So you've left the local muscle, and you're now into the entire physiological system, and its ability to produce and sustain work. And we can get into a bunch of differentiations with an endurance, but just to keep it really simple right now, the very first one, think about this as, I call this anaerobic power, right? So this is your ability to produce a lot of work for say 30 seconds to maybe one minute, kind of two minutes like that. The next one down then is more closely aligned to what we'll call your VO2 max. So this is your ability to kind of do the same thing, but more of a time domain of say three to 12 minutes. So this is going to be a maximum heart rate, but it's going to be well past just max heart rate. Then after that we have what I call long duration endurance. So this is your ability to sustain work. The time domain doesn't matter in terms of how fast you're going. It's how long can you sustain work? This is 30 plus minutes of no break. Like that. So as just an high level overview, those are the different things you can target. And again, some of those crossover, and some are actually a little bit contrarian to the other ones. So pushing towards one is maybe going to sacrifice something else. So as an overall start, that's really what we're looking at. Within all those though, they do have similar concepts, in terms of there is a handful of things you have got to do to make all of those things work. And we could talk about as

many of those as you want, but one of them is functionally called progressive overload. So whichever one you're trying to improve at, if you want to continue to improve, you have to have some method of overload. And as you well know, and you've talked about a lot, adaptation, physiologically, happens as a byproduct of stress. So you have to push a system. So if you continue to do say the exact same workout over time, you better not expect much improvement. You can keep maintenance, but you're not going to be adding additional stress. So in general, you have to have some sort of progressive overload, and we can talk in detail about what that means for each category. But this could come from adding more weights. This could come from adding more repetitions. It could come from doing it more often in the week. It could come from adding complexity to the movement. So going from say a partial range of motion to a full range of motion, or adding other variables. So there's a lot of different ways to progress. But you have to have some sort of movement forward. So if you have this kind of routine where you've built Monday, Wednesday, and Saturday or something, and you just do that infinitely, you're not going to get very far. So that's, I guess the most high level overview of all the things people can go after, and then we can go from whatever direction you want from there. - Well I'd love to do the deep dive on each one of these

00:14:40 Modifiable Variables, One-Rep Max, Muscle Soreness

- Yeah man. - for several hours. But, and I imagine that over time, we probably will. I'd love to chat about a couple of these in a bit more depth. So in terms of defining what the progressive overload variables are, - Yeah. - for these different categories, maybe we could hit the two most common combinations of these nine things. The first one being strength and hypertrophy. - Yeah. - And maybe we could lump power in there. Maybe not. You're the exercise physiologist. - Yes and no, yeah. - But strength and hypertrophy, which at least bears some relationship. And then maybe separately we could explore sustained work endurance. This 30 minutes or longer continuously, 'cause I think many people train in that regime. And probably something like VO2 max anaerobic as well, because I know that a number of people now incorporate so-called HIIT or high intensity interval training, I think with the hopes of either shortening their workout. - Yeah. - And or, gaining some additional cardiovascular benefit. So if we could start with strength and hypertrophy, I know many people want to be stronger. They want to grow larger muscles, or at least maintain what they have. So what are the progressive overload

principles that are most effective over time for strength and hypertrophy? - Yeah, okay. So I'll actually go a little step back. With every one of those categories I talked about, you have what we call your modifiable variables. So this is a very short list of all the things you can modify, the different variables within your workout that can be modified, that will change the outcome. A fancy way of saying, if you do this differently, then you're going to get a different result. So modifiable variables. The very first one of those is called choice. So this is the exercise choice that you select. Now one of, I'm going to go double back here, so I'm kind of doing a little bit of inception. So follow me here as I'm going up a layer to come down a couple layers. I have these fundamental laws of strength and conditioning that, they're kind of like a little bit of a joke. But progressive overload's one of those laws. Another one of those laws is your exercises themselves do not determine adaptations. So here's what I mean. If you're like I want to get stronger, you can't select an exercise. That doesn't determine you getting strong. If you don't do the exercise correctly, and I'm not even referring to the technique. That of course matters. But if you don't execute it in the right fashion, then you're not going to get that adaptation. So if you choose I want to get stronger, I'm going to do a bench press. Well, if you do the wrong set range, the wrong repetition range, the wrong speed, you won't get strength, you maybe get muscular endurance, and very little strength adaptation. So the exercise selection itself is important, but it does not determine the outcome adaptation. So the very first thing that you need to think about if you're like I want to get stronger or add muscle, is not the exercise choice, right? It is the application of the exercise. What are the sets, what are the reps, what are the rest ranges that you're using? That's going to be your primary determinant. Now some exercises are certainly better for some adaptations. For example, a deadlift is probably not a great exercise to do for long duration endurance. Like you could theoretically do 30 straight minutes of dead-lifting, but it's probably not our best choice, right? It's probably a pretty good choice for strength development, right, 'cause you're going to do a low repetition, high set range. You could theoretically do bicep curls for power, but probably not your best choice, right? Single joint isolation movement is not the best for developing power. If you've ever done a bicep curl as fast as you possibly can, like that's not going to go well. So in theory, any exercise can produce any adaptation, given the execution is performed properly. So now that we've understood that a little bit, the exercise itself does not determine the adaptation. Coming within each one of these categories, exercise choice is an important variable because it does lend you to things like what movement pattern

you're in. So in other words, if you want to get stronger and you're thinking, okay, what exercise do I do, you need to think a little bit about what muscle groups do I want to use, and that's going to be leading you towards the exercise choice. For example, I want to use my quads more. Okay, fine. Maybe you're going to choose more of a front squat type of variation, a goblet squat, so the bar, the load is in front of you. If you want to emphasize maybe more of your hamstrings and glutes, you're going to maybe put a barbell on your back or do a different one. So the exercise choice is important to the prescription because it's going to determine a lot of your success. Okay, another kind of simpler way to think about this. If you're a beginner, or moderate to intermediate, or maybe you don't have a coach, you probably want to hedge towards an exercise selection that is a little bit easier technically. So you maybe don't want to do a barbell back squat. It's actually a pretty complicated movement. Maybe you want to do a little bit more of, again, a goblet squat, or even use some machines, or a split squat, something that's a little bit simpler because you don't have a coach, you're not a professional athlete. The likelihood of success is higher, and the risk is now gone lower. So the very first variable within all of these is the exercise choice. The second one is the intensity, and that refers to, in this context, not perceived effort, like, wow, that was a really intense workout. It is quite literally either a percentage of your one rep at max, or a percentage of your maximum heart rate or VO2 max. So for the strength-based things, you want to think about what's the percentage of the maximum weight I could lift one time, and that's what we're going to call one rep max. Or it's a percentage of my heart rate, right? So if I tell you to get on a bike and I want you to do intervals, and I want you to get 75%, I'm typically referring to 75% of your max heart rate, or VO2 max, or something like that. If I tell you to do squats at 75%, that means 75% of the maximum amount of weight you could lift one time, or close. - In terms of determining one rep max, I confess I've never actually taken the one rep max for any exercise. But I have some internal sense of what that might be or what range it might be. Is it necessary for people to assess their one repetition maximum, before going into these sorts of programs? - No, not at all. I think a more intuitive way is to take a repetition range. Well, you can do this a couple of different ways. So there are equations you can run, and you can just Google these anywhere, and these are called conversion charts. And so it says okay, if I did 75 pounds on my bench press and I did it eight times, you can just run an estimate to say, okay, you're probably going to be able to bench about 95 pounds for one rep max or something. So that's a very easy conversion chart. So just pick a load that you feel comfortable with, but

it's kind of heavy but not like crazy heavy, and do as many repetitions as you can with a really good technique. And then look what that number would be. So conversion charts. - Probably safer than doing it one repetition maximum. - For the general public who has, again, no coaching, it's safer. For a professional athlete, it's not any safer, but, or not even a professional athlete, but a trained person with a coach. But for most people, yeah, that's a good way to go about it. You can also just kind of do it with feel, in the sense that say you want to do a set of five repetitions, and you do the load, and you think I could've done one or two more. And then you kind of have an idea of what that number's going to be. If you think, man, that last one I had to kind of really, really, really get after it, then maybe just call that that number, right? So you don't have to get overly concerned. In fact, when we start getting into these number ranges, you're going to see that they're all ranges. We're not going to give a specific 95%, for one of these exact reasons. It's not that precise for most of 'em. In fact, some of 'em like hypertrophy have enormous ranges that you like almost can't miss. So the intensity in that case doesn't even matter for the most part, because that's not the primary determinant. Some of these you're going to see intensity as a determinant, and some of these you're going to see volume is the true determinant. So intensity though is that second one, choice was the very first one, manipulable variable. Intensity was the second one. The third one is what we call volume. And so this is just how many reps and how many sets are you doing, right? So if you're going to do three sets of 10, that volume would be 30, right? Five sets of five, that volume is 25. It's just a simple equation. How much work are you totally doing? The next one past that is called rest intervals. So this is the amount of time you're taking in between typically a set. Then from there, you have progression, which is what we started to talk about, this progressive overload, are you increasing by weight, or reps, or rest intervals, or complexity, or whatever. So all of those things can be changed as a method of progression. And so maybe you want to go progressing from a single joint exercise, like a leg extension on a machine, and you want to progress by moving to a whole body movement like a squat. That in of itself, you don't have to change the load, or the reps, or the rest. That is a representation of progressive overload. And it's probably a pretty good place to start, because number one, especially for beginners, you want to make sure that the movement pattern is correct. Don't worry about intensity. Don't worry about rep ranges or any of these things. You need to learn to move correctly, and you need to give your body some time to develop some tissue tolerance. So that you're not getting overtly sore. In general, soreness is a terrible proxy for

exercise quality. It's a really bad way to estimate whether it was a good or a bad workout, especially for people in that beginner to middle to moderate. In fact, even for our professional athletes, we do not use soreness as a metric of a good workout. It's a really bad idea for a bunch of reasons. On the same token, because stress is required for adaptation, you don't want to leave the gym and feel like I didn't really do much. There has to be there. So if you think about soreness on a scale of one to 10, you probably want to spend most of your time in like the three. - You mean post-exercise? - Yeah. - In between workouts. - [Andy] Totally. - And I know we'll talk about recovery extensively later, but if one body part or set of body parts is sore, is that an indication that one should stay out of training? I would imagine the answer is no. - Right. - In most cases. And secondarily to that, if a particular muscle is sore, does that mean that muscle is not ready to be trained again? - Yeah, the answer to both those is the same, which is no. Right? You can certainly train a sore muscle. You need to, I guess, have a little bit of feel on that, right? So if you're sore of like, okay, and you're moving around a little bit and you're like, man, this is a little bit sore, you can train. If you're like, I can't sit on the couch without crying because my glutes are so sore, like we probably don't need to train again, right. - Does whimpering count as crying? - Yeah, in that particular case I'd say you've actually gone to a place of detriment, because now you're going to have to skip a training session. And now you're behind, so your actual total volume say across the month is actually going to be lower because you went way too hard in those workouts, had to take too many days off in between. You're going to see that you're going to cover less distance over the course of a month, or six month, or even a year. So you want to walk a pretty fine line, and for most people I would say hedge a little bit on the side of less sore than more so. Because frequency is very, very important for almost all these adaptations. - Training frequency. - Which is the last modifiable variable, right? Frequency. Which is how many times per week are you doing that thing? So those are, kind of are global things that we can play with. So when I'm trying to manipulate, and you can get strength versus hypertrophy, or, you know, I want like a little bit of both, all those variables are the things that are going through my mind. Which one do I need to move in which direction, so that I can get this outcome and not this outcome over here? For example, some folks might want to get stronger, but not put muscle mass on. Some folks just kind of want both. And that's a lot of the general public. I want to get a little stronger and a little bit more muscle. Great. But there are instances where people, for performance reasons or for purely personal preference, like I don't want to get any more

muscle, great, but I want to get stronger. Awesome. If you manipulate those variables correctly, you can get exactly that. Very little development of muscle size, and a lot of development in strength. And this is why we continue to break world records in sports like power lifting and weightlifting, that have weight classes. So there's a top number that we can hit in terms of body size, but yet we continue to get stronger and faster. So this is very possible, if you understand how to manipulate all those variables. So that being said, we can start off with, you wanted to go strength and- - Yeah strength, and I love that you mention the fact that it is possible to increase strength without increasing muscle size, at least not dramatically, because think it's not just weight class athletes. I know a lot of people who, for aesthetic reasons, they'd like to be stronger, they're hearing that having strong bones and strong muscles and tendons, it's great for longevity and for avoiding injury, and so many other features of life. And yet they don't want to fill out progressively larger and larger sizes of clothing. - And we can go harder to the mechanisms on that piece

00:27:30 Modifiable Variables of Strength Training, Supersets

if you want, or we can save that and come back to it. - Sure. What I'd love to, both, what I'd love to know was if we could define some of these modifiable variables, - Yeah. - in the context of strength. So let's say I- - Oh okay, yes. - was somebody who, I come to you and I say, and let's just say for sake of balance here, 'cause she actually does do some weight training. I bring my sister in, and I say, me and my sister both want to get stronger. What modifiable variables should, how should we modify the variables? - Love it, all right, great. I'm going to do inception on you one more time. So one of my other laws, this one will be fast, I promise, of strength and conditioning, is in general, the default is all joints through all range of motion. So this is important because it's going to answer your very first question on this strength category. So in general, the ankle should go through the full range of motion in the ankle. The knee should go through the full range of motion in the knee. The hip, the elbow, et cetera, et cetera, right? - Across the workout, not in a single movement. - Well, right. - I would hope. Unless there's an amazing exercise I haven't heard about. - Well there are some exercises that we're going to call more full body. Think about a full snatch. Like you're going to take a lot of your muscles, a lot of your joints through a lot of the range of motions. Other ones like in isolation, we call these single joint exercises. So imagine a bicep curl. You have one

joint in that particular case, the elbow moving. The shoulder and everything else is pretty much stable. And this is how we'll differentiate multi-joint from single joint movements. But yeah, so across, I would even say it doesn't even have to be the day, but maybe throughout the week, try to get every joint through full range of motion. Now, a couple of quick caveats to that. I am not advocating using full range of motion, and allowing really bad exercise technique. So when I say full range of motion, that's the default. That doesn't mean every single person can do that for every single exercise. It means that's where we should be striving to, and that's our starting point. You're going to see a lot less injury and a lot more productivity out of your training sessions. In fact, the science is fairly clear on this one. Strength development as well as hypertrophy is generally enhanced with a larger range of motion of training. And the mechanisms are like somewhat understood on that. So that being said, if you have to get into say a bad position with your say lower back, the spine is a very good one. In general, the spine should stay, it's very neutral is what we call it. So no flexion, no extension, especially in the lumbar region. So if you're doing a, say a deadlift, and in order to take your knee through a full range of motion or deadlift, you have to compromise your back position, that's no [speaking in foreign language]. So, caveats there aside, don't kill me, like in good positions always. - And don't kill yourselves. - Yes. - More importantly. - So why that matters is if we walk through strength, the very first thing I'm going to go through is the exercise selection. So let's choose an exercise which ideally has a full range of motion or close to it, that doesn't induce injury for you, that you can still maintain good neck and low back and position and everything else. You feel comfortable with, so you can feel strong but you don't feel like, oh my gosh, if you've never snatched before, having you do a snatch for a maximum, even 75%, like it's a terrible idea. You're not going to feel confident, it's going to be a train wreck. I would rather put you on a machine bench press, so you can go I feel stable, I feel safe here, and I could just express my strength. So exercise choice in general, full range of motion, and you want to kind of balance between the movement areas. So this is an upper body press, so this is pushing away from you. Bench press, things like that. Upper body pull, pulling an implement towards you. Bent row, pull up. The pressing should be horizontal. So perpendicular to your body, as well as vertical. So this is lifting a weight over top of your head, lifting a weight away from you. The pull version is pulling horizontally to you and pulling vertically down. Pull up, things like that. From the lower body, we typically call these hinges. It's sort of a funny muscle thing that no one's going to laugh at, but like maybe me and you

here, is we'll categorize muscles as, or movements, exercises, as pushes and pulls, right? So like a squat tends to be a push, 'cause you're pushing away the ground. A deadlift is a pull, 'cause you're pulling the implement up to you. But in reality, every single exercise is only ever a pull, 'cause muscle doesn't push things away, muscle can only contract and pull on itself. And so again, super nerdy thing that like most people are like, yeah, and everyone's like, that's so dumb. - No, but I think it's a really important point because it also speaks to something I think we'll get into later, which is that, you know, posterior chain, anterior chain. - [Andy] Totally. - And if that's mysterious to people, it'll become clear before long. Posterior chain, anterior chain, makes a lot of sense to me because of the way it's grounded in the firing of motor neurons, which is ultimately what controls muscle. So it's also I think- - You and your nerves all the time. - Exactly, so it also depends on the lens through which one looks at life and exercise. Of course my lens is primarily neuroscience. But I realized that the importance, I like this idea of pushing perpendicular the body overhead, pulling both toward the body and from overhead. That just makes really good, intuitive sense, especially since a lot of people are just listening to this and not watching it. So in your minds, folks, you can think about pushing away like a punch or overhead, like lifting something overhead, and then pulling toward your midline or towards your body rather, and then pulling yourself up like a pull up in PE class, for those of. - Yeah. - That experienced- - So the lower body's the same thing, right? It's some sort of pushing away like a squat, or a split squat, or a lunge, or something like that. And then some sort of, again, what we'll call pull or hinge. So a deadlift or Romanian deadlift, or a hamstring curl, or something where you're contracting and pulling the thing. And you could split these into like a thousand different categories. If you're really in that field, you're going to want to add a bunch of other ones. But that's just like a rough conception, so if you're going to do a single workout, you could choose four exercises, and you could choose one of each. One press, upper body press, one upper body pull, one lower body hinge, one lower body press. And then that would be like a decently well-rounded exercise. That's your exercise selection. And if you're taking those through a full range of motion, you're at a pretty good spot. As close as you can. The next one is intensity. So if you want to develop strength, this comes back to one of my favorite scientists of all time who happens to be a nerve guy actually. And generally, I like to shit on nerves as much as I possibly can, 'cause I'm a muscle guy. But I have to give Henneman some credit here, right. And I know you know who that is. - Henneman size principle. - Yeah, of course, right? So this is a series of papers, I think in the, I think

it was in nature. - At least some of them, yeah. - Yeah, in 1954, '56, or like something. You can fact check me, I'm sure you will. But he basically outlined this idea that, okay, there's a certain recruitment threshold needed for neurons to fire. And we have muscle fibers in what we'll call fast twitch muscle fibers and slow twitch muscle fibers. And in general, you're going to activate the slow twitch ones first because they tend to be associated with low threshold motor neurons. It's not exactly that way, but it's close enough, right? Well, the only way that you activate some of these higher threshold neurons is to demand the muscle to produce more force, and it's fairly specific to force, right? It's not something you can do over an endurance thing, right, unless it gets really extreme and fatigue happens. So in general, the only way to use these big chunks of your muscle, which are incredibly important for aging by the way, one of the major problems we have with aging developing or development of aging-related issues with muscle, is the fact that we lose fast twitch fibers preferentially. And then we have major problems as we go down the line, because we've lost a big chunk of our strength in size. So you want to make sure these fibers stay alive and intact. Okay, so if that being said, the only way to develop strength is then to challenge the muscle to produce more total force. If you are fairly untrained or new, I guess I should have stated this all at the beginning as well, one more inception then I'll stop. When it comes to this level of detail of exercise prescription, a fairly untrained person is going to respond basically the same to every single thing you do. In fact, we've done this in the lab many times, we've done training studies doing things like 30 minutes of cycling, and seen huge increases in muscle strength and size, which is not a prescription for most people to increase size, but people that are really untrained, if you did plyometrics or strength training or endurance running, they all just get better at everything. So that caveat kind of aside, if you want to be more intentional and more specific to the goal of strength, you need to produce more force. Specificity matters, right? So we have size principle to help understand this. And we have our laws of specificity which say SAID principle, right? Specific adaptation to imposed demand. So the adaptation you get, or the result of your training, is going to be a reflection of the demand that you imposed. So if you want to get stronger, you need to impose a demand of strength, not repetitions. So this has to be, the load has to be very high. In general, you're probably looking at above 85% of your one rep at max. If you're moderately trained, maybe 75% will work. Lowly trained, again, everything works. But in general, we want to be pressing a load that's very high. So because the intensity demand is so high, that is going to force you to do a low repetition

range. You can't do 12 reps at 95%. Then it wouldn't be 95% of your one rep at max. So by definition, true strength training is really going to be in the like five repetitions per set or less range. That's where most of it's going to occur. With specificity. So we've covered choice, intensity, and repetitions, right? The total amount of sets that you do is really kind of up to your personal fitness level, right? If you did as little as like three sets per exercise, that's probably enough. - Work sets. - Totally, yeah, totally work sets, right. So get fully warmed up and build up to that 85%. Don't just walk into the gym and throw 85% on and go thank you, that's an important distinction. So work your way up. Do some, like a very classic warm up thing would be like a set of 10 at 50%. A set of eight at 60%. A set of maybe eight again at 70%. And then maybe like a set of five at 75%. So two or three or four sets kind of building intensity and lowering rep range. And then you would go after your two or three working sets. Also, in terms of rest intervals, now, because we're trying to, the primary driver of strength is intensity. It's not the volume, right, it's the intensity. So in order to maintain that we have to do a low repetition range. But in addition, we also have to have a high rest interval. Because if we start to, if we have any amount of fatiguing occur, and we have to then either reduce the reps or reduce the intensity, we've lost the primary driver. We've lost that main signal. So the number we're going to throw out typically is like two to four minutes. So imagine you did your set of bench press and you did five repetitions at 85%. You probably want to rest two to four minutes before coming back to the bench. That doesn't mean you have to sit there on your phone. In fact, please don't. Everyone will thank you for not doing that, I promise. You can engage other muscle groups. This is what we would call super setting. So you're doing your bench press, and while that two minute clock is running for your chest, to rest, you can go over and do your deadlifts. And so you can kind of move back and forth, and this is how you can make strength training not a seven hour workout. If you're a professional athlete, you're going to take that time, because you want to maximize the outcome. We've done this actually in our lab too, super sets will reduce the strength gains, but by a tiny amount, and most of us don't care enough, relative to it's going to triple the length of your training session. It's not worth it. So for the average person I will tell them, yeah, super set. For someone who's trying to break a world record in weightlifting or power lifting, don't super set. - Interesting. Yeah, I think, I've found that I don't recover particularly well from strength and hypertrophy training. So- - Like in the workout or the next day? - From workout to workout, unless I keep the total duration of those workouts, I like to say no more than 60 minutes of work, of real work. - Yep, yep. -

Maybe 75. Past 75. I find that I just start to- - [Andy] That's a lot. - I have to introduce additional rest days, or I just get weaker over time. So I'd set a kind of a limit at 50 minutes and then I usually violate that limit and end up doing 60 minutes. So I'm excited to hear that one can super set exercises, as long as they work different muscle groups, of course. - Yeah. - Right. So I wouldn't want to do like bench press and overhead press, super set it, 'cause you're going to weaken- - Yeah. - I think that goes without saying for most people, but just to point that out. But that I could do some push, pull, push, pull, without compromising total intensity that much. And I certainly would be willing to give up a rep here or there, or a few pounds here or there. And may I ask whether or not in doing that, one gets any even tiny bit, or more of additional benefit in terms of cardiovascular work? Because I imagine after a, even a one rep max which I've never done as I mentioned, but let's say I get three reps on the overhead press and then I get four reps on a weighted pull up, and I'm going back and forth. I'm no doubt going to be breathing harder than if I was sitting there texting away on my phone. - Yeah. - In between sets. - Yep, of course. Yeah, and so in fact in general, one of the things that I'll present in my class is a giant list of, in fact on the top is all these different exercise adaptations I started the conversation with. And on the vertical column are as many of the physiological potential adaptations one would get. So changes in endogenous pH. Blood pressure. Lymphatic changes. Bone density. All these things, right, and just have this giant list. And then you can run a matrix and you can start to look at, okay, if I do speed training, am I going to see changes in the nervous system? Well, like very much so, right? That's the primary, actual reason those things work. Very little change in the muscle system. It's almost exclusively explained by the central or peripheral nervous system, right? On that same token, are you going to expect many cardiovascular adaptation from speed? And the answer is no, because although we didn't cover it, speed is very low intensity, very low rep range, very high rest. Well, as you go to like strength and then you go to hypertrophy, you start seeing more and more increases in cardiovascular adaptations because you're doing exactly that, right? You're starting to reduce rest, and you're starting to increase volume. But you're going to lose things like bone mineral adaptations, because the load starts to go down. So you can look at this matrix and kind of understand if I'm a person who wants to kind of maximize the adaptations I get across my entire physiology for the least amount of work, you can choose these different adaptations to go after that are going to kind of land on these things, right? And exactly as you mentioned, if you're going to take five minutes rest

between each rep. So let's say the extreme, you're going to do three sets of one repetition for strength at 95%, you're going to take probably five, maybe seven minutes between each attempt. Like you better not expect many like changes in your resting blood pressure. That there's no cardiovascular strain there. You're going to put it together in a circuit where you're going to lose some potential strength adaptation, but you're going to gain something there. So all these things are, it's not about good or bad or right or wrong. It's always about what advantage do you want and what disadvantage do you want? And I can cut like really in to the chase here on one of these things, 'cause we'll get to this eventually. If you want to know the ones that are going to generally give you the most physiological adaptations across the most categories, you're almost always looking for hypertrophy type of training. And then this anaerobic conditioning piece that we'll get into. That's going to hit the most systems at once. - That's great to know, and we should definitely go a little bit deeper on those types of what the modifiable variables are for those categories. 'Cause I think that, I'm guessing the vast majority of people want to be a bit stronger, maybe add some, a little bit of muscle, or more, make sure their heart is healthy and et cetera. This is wonderful, and I think is clarifying certainly a lot for me. So for strength, let's, I guess training frequency.

00:43:50 How to Select Training Frequency: Strength vs. Hypertrophy

- Frequency, cool. - So what should determine training frequency? And I had the great benefit of a long time ago when I was in high school actually, I paid for a session over the phone with Mike Mentzer. - Oh, lovely! - Yeah, the Mike Mentzer. - Sure. - And we got to be friends, over time. - High intensity training! - At the time I was pretty young and my mother kept saying like, why is this like grown man calling the house? And then we would talk all the time about training, but he tried to convince me to train once every five to seven days, very few sets, very high intensity. And I must say, it worked incredibly well. - Sure. - It was, I think with my recovery quotient, which was not very good, I think has improved over time but was not very good, it was remarkable. But of course this was a time when I was, you know. - Full of the most animalism - I was 14. - you've ever had. - On my own version of anabolics, right. I had a long arc of puberty, so. - And you were untrained. - And I was mostly untrained. I'd been running cross country and skateboarding, and playing soccer. So. - And doing all the things that are like the antithesis of growing muscle. - Yeah, it was literally, and people would probably say

impossible. It was something like 40 pounds of muscle inside of 12 months. It was crazy. - [Andy] I would believe that. - And so, then of course that stopped working over time. - Sure. - And then you start going down the odyssey of trying to find the thing that's going to work that well. And you eventually realize that it was because you were untrained, right? So training frequency is crucial. Let's say that people are doing these whole body workouts as you've described them, not alternating upper body, lower body, 'cause there's so many different splits that we talk, probably doesn't make sense to go into splits right now. But how often can and should one train a muscle? And how do you know if a muscle is recovered locally? And how do you know if your nervous system is recovered systemically? - Okay, this is a bunch of really interesting questions. I'm not sure exactly what route you want to go, so I'll start here. As I mentioned earlier, soreness is not a good barometer of exercise quality, because some types of training are going to induce more soreness and some are going to induce less. That's important to this conversation because when you ask about how do you know if a muscle is ready to train again, one of the question is, well what are you training for? If you're training for hypertrophy, right, muscle size, muscle growth, we need to hedge towards recovery. Because what you're trying to do is cause a massive insult there, allow then protein synthesis to occur, building of new tissue which takes time, 48 to 72 hours, like kind of at a minimum, that process needs to occur. If you're doing actually more strength, and this is a differentiation between hypertrophy and strength, then you didn't induce actually much damage. In fact, you're generally not going to get very sore from true strength training. Very little, unless you get really heavy, you did it a lot. The primary driver of hypertrophy is not the same primary driver of strength. We talked about that already. That's intensity driven. For hypertrophy it's not intensity. So because we have different mechanisms, we have different outcomes, even though they're closely aligned, strength is not going to cause a lot of soreness. Therefore intensity is the driver. Therefore frequency can be as high as you want. So you can train every single day the same exact muscle, if speed or power or strength are the primary training tools, because you need stimulus, there's skill as well, right? Practice. You know that as much as anybody. Developing a new motor pattern requires a lot of repetitions, right? You don't need a tremendous amount of rest. That's not, it's not a damage thing, right, it's a re-patterning issue. So strength training, in fact, if you look at again, true strength professional athletes, they're going to train the same muscles basically every day. - Wow. - [Andy] They're going to squat every day. - And is that because the primary mode of adaptation

is recruitment of these high threshold motor units? So it's mainly neural. - No. So everyone's going to say that. And this is where I get all feisty. - Well, I'm not saying that. That was actually, there was a question mark there. - [Andy] Okay, okay. - If we were online putting comments, there'd be a question mark. - We would've fought. I would've blocked you. I'm just kidding. - You already blocked me. No. - Probably twice! Okay. The early adaptations to exercise, especially strength training, are hedged towards the nervous system. No question about it. People always say central nervous system, but it's probably more peripheral, right? Whatever, semantics probably, but pedantic. It's nerve, if you train today, tomorrow morning you're not going to wake up with a actually increase in contractile proteins and muscle. Your muscle might be a little bit bigger due to some acute swelling, but you could have a pretty acute that persists, change in the nervous system we'll call it, that allows you to be stronger, like within a couple of days. Sustained hypertrophy is probably more along the lines of four weeks. We can see that right? We can actually see changes like in the ultrasound. Now you're making changes immediately, that protein synthesis process is happening like very fast and it's going to last. It just takes us time to measure it in terms of a noticeable change in your whole muscle size. So that being said, the first four weeks we typically say are primarily nervous system. After that, now we're starting to see most of the changes coming from the muscle side of the equation. So with strength development, it's a combination of three areas. In fact, all muscle contraction has these same three things. It starts off with some signal, right, from somewhere in the body, whether it's all the way up the top or at the level of the spine, depending on if this is a reaction or an actual conscious control. From there, some signal has to tell the muscle to contract. Okay. So signal is one. Two it's muscular contraction. And there's a lot of variables inside the muscle tissue itself that determine its functionality. And so if we took an individual biopsy and took a muscle fiber from you and took one from me and we took those muscles out and put them in a Petri dish, and I tied one end to a force transducer and the other end to a thing that pulls it, and we soaked it in a bath of calcium and a bunch of other stuff, even if they were the same size, your fibers might contract a lot faster than mine, even relative to size. Or not, or slower, or there's various properties. So the intrinsic fibers themselves determine a lot of functionality. From there, muscle fibers don't cause movements. Muscle fibers simply contract. They're all surrounded with connective tissue. And that's all surrounded with a bunch of more connective tissue. That all surrounds into a muscle. That muscle is then surrounded with more connective tissue. That all comes together into a giant tendon.

That tendon attaches to the bone. It's the pulling on those tendon that actually move the bone that cause human movement. So that's area three. Area one, the nervous system, area two, the muscle contraction, area three, some sort of connective tissue thing. Changes happen at all three of those levels. And we're not even now talking, when you entered the discussion of biomechanics, and you changed say the pennation angle of the muscle, which is the angle at which the muscle fibers lay relative to the bone, right? So this is basic mechanics. Is it pulling perpendicular to the bone? Is it pulling horizontal to the bone, or some sort of angle? All of these things determine human performance. So when you're talking about again, that strength development, you can see tremendous improvements in total force production by manipulating all of those areas, and you have not touched changes in muscle size. If you change muscle size in a true sustained fashion, whether this is sarcoplasmic or contractile proteins, you have given yourself more opportunity to produce more force. It doesn't guarantee you produce more force. Bodybuilders are not stronger than power lifters, even though they have more muscle. But bodybuilders are probably stronger than most people. So there is a relationship between muscle size and strength. It's just not a one-to-one guaranteed ratio. And that's generally because the, although the muscle has been aided, they may have not changed the biomechanical considerations. They may have not changed the connected tissue nor the nervous system stuff. And so that's why we see this giant relationship that our value is pretty high between strength and hypertrophy, but if you really want to get to the ends of it, it's not. And that matters to your actual question 10 minutes ago, because again, you can train strength daily on the same muscle, but if you want to allow for that process of contractile proteins to add and grow, then you're going to have to allow some recovery. Because if you go back into that muscle too soon, you're going to blunt the response. You're going to stop it. You're going to cut it off. You have all kinds of problems going on in the cell that are going to just attenuate that growth response. So I gave you the answer for strength training. The answer for hypertrophy is probably less than three out of 10, on level of soreness, so you can go again. In general, you're probably looking at 72 hours is the optimal window. So if you trained your shoulders on Monday, you probably don't want to train 'em again on Tuesday. If hypertrophy's the goal. Maybe Wednesday, maybe Thursday's best. So something like an every two to three day window is probably, and we know a little bit more now about why that is. The gene cascade, the signaling and response happens, well the signaling happens instantaneously, right, within seconds. The gene cascade is probably in the, peaked in

the four hour window, like depending on which gene you want to look at. But it's just kind of a snapshot. But the protein synthesis process is 24 to 48 hour thing, and so it tends to kind of look like let that thing finish and let that signal go back to baseline, and then hit it again. And then hit it again. And now as long as you're providing the nutrients, the recovery should happen and you should be able to sustain the same work output in the training session. So the stimulus stays high and the recovery's there, and you can now continue to grow muscle. - You mentioned 48 to 72 hours for hypertrophy. What if, for whatever reasons, the training split, lifestyle factors, et cetera, somebody say, let's use your example, trains shoulders on Monday, ideally they would train them again on Thursday, in their particular instance. Wednesday or Thursday. But they don't. They wait until Saturday or Sunday, for whatever reason. Maybe it's more compatible with their work and other exercise schedule. Whatever the reason. Are they actually losing hypertrophy that they gained, or they've missed a window to induce further hypertrophy? - It's probably better to think about it as the latter. It's not that you've lost, it's just, you've just kind of lost an opportunity to make more progress. I will save you a little bit, kind of going back to your HIIT program. This is the original high intensity training, the Mentzer thing, right? Which is not. - The HIT with one I not the high intensity interval training, but high intensity training. - Correct. - Like one set to absolute failure. - Totally. - Maybe two. For each muscle group. - 20 minute workouts. - [Andrew] Dividing your body into a three-way split, and then literally training like - Smashing. - six times a month. Which most people think that is absolutely crazy. - Yeah. - There's no way that's going to work. And I can tell you this. - It does. - If you are untrained, you grow like a weed. If you train hard enough. - Even if you're trained, look at the people Mike trained. He put a lot of bodybuilders on really high levels. Now they had the same similar help you had at that timeframe. - Wait, to be very clear, I was not taking exogenous anabolics. In fact I- - But your endogenous was just as good. - It probably was. I wasn't measuring my levels there, but I probably would. I grew easy and, in general, I tend to grow pretty easily from weight training. And I should say that, to Mike's credit, and I think this is an important message, that he was the one who really said look, unless you're going to make a professional career out of it, do not run the health hazards of exogenous hormones. And certainly not at your age. So he deterred me from that, which was great because it never entered my mind. It just was one of those things where Mike Mentzer said don't do it. And he had clearly done it, right? And so he's speaking from an informed place. It never entered my mind. But also what was really wild is I was continuing to run cross country.

And so there was a trade-off there at some point. - A bit of an interference. - But when you're young, you can get, many people can get away with, - Totally. - with what at this age would surely place me into a state of over-training, even at low volume. We'll see. - Yeah, well I mean like, the whole field on interference effect has changed quite a bit recently, which we could come back to if you want. But just to finish out the idea here with that last question. If you want to take five days or six days in between each muscle group, you can do that. In fact, if you look at the research, it's going to show that frequency is not that important. It's not that it's unimportant, but it can handle changes, as long as you get to the same total volume. So you can do that. You just have to do a lot more work in that one workout. If you care about the six week, eight week thing, if you're like I'm in this for the next 60 years, like it's probably okay, right? But it can be there, the challenge with splitting up your training sessions for hypertrophy into smaller numbers, like once or twice a week, it's just difficult to get that number. It's difficult to get that volume done. Volume-wise, the more recent meta analyses are going to say that you're probably looking at around 10 working sets per muscle group per week. Seems to be kind of the minimum threshold that you're going to want to hit. So if you did three sets of 10 at your shoulders on Monday, three sets of 10 shoulders Wednesday, and three on Friday, that's nine working sets. If you wanted to do three different shoulder work exercises on Monday and hit your nine sets, it's not really actually going to be that much different. The problem is 10 is kind of the minimum. You probably want to look for more like 15 to 20, and in fact, well-trained folks, 20, 25. That becomes very challenging in one workout. In fact de functo, you're not going to be able to do it, right? And so that is where, it's not the frequency that looks like it kills you, it's just the fact you have got to get, because the total driver of strength is intensity, but the total driver of hypertrophy is volume. Assume you're taking it to fatigue, right, or muscular failure. So it's just tough to get enough done. If you can, and if you want to set your schedule up that way, like you probably remember, if you do those types of training sessions where you're just going to completely exhaust a muscle, it's going to be sore for a while. You're probably not going to come back, and that's sort of the logic behind that was let's take this thing to tremendous failure and give it six days to recover. It can work, it's just not the best, I think is one way to think about it. For most people. - It's also hard to do those workouts without a training partner, if you really want to do them correctly. - And stimulants and headphones and all kinds of other things, right? - Well, anyway, yeah stimulants are not, I certainly don't recommend those. It may be a cup of coffee or two, if that's your thing,

but, and maybe some of the safer supplements, but certainly not the sorts of stimulants that the guys in the '70s and '80s

00:58:45 Hypertrophy Training, Repetition Ranges, Blood Flow Restriction

were famous for taking. - No way, or still use. - Or still use. You talked about repetition ranges, broadly for strength training, so five or less. You said frequency could be as often as every day. Rest two to four minutes, maybe even longer if you're going for one repetition maximum. - Yep. - [Andrew] For hypertrophy. - Sure. - What are the repetition ranges that are effective, and what are the ones that are most effective, if one is trying to maximize some of the other variables? Like people don't want to spend more than an hour to 75 minutes - Realistic. - in the gym. Because I think that while the rep ranges might be quite broad, as you alluded to earlier, there's the practical, there are the practical constraints. - [Andy] Yeah. - So what repetition ranges or percent of one repetition maximum should people consider when thinking about hypertrophy? - Right. The quick answer there is anywhere between like five to 30 reps per set. That's going to show across the literature pretty much equal hypertrophy gains. And we can have a really interesting discussion about why that is. But I'm just remembering one thing from a second ago. I want to give a better answer for the frequency. You can do every single week for strength, or every single day for strength. If you want though like what's probably minimally viable, two, twice per week per muscle. So hamstrings strength, twice per week. That's a good number to get most people really strong. - Okay. - You can do every single day. You don't need to though. So I want to make sure that, like I wasn't saying you have to train a muscle 85% every single day to get it strong. Two is a good number, three is great, but probably even two is really effective. - Got it. And this explains the high frequency of training for strength athletes that's always mystified me. - Yeah. - And the very long workouts make sense, because very long- - They're going to even train twice a day. Even they'll just squat, in the morning squat and the afternoon, every day. - With their eating and their sleeping, they probably don't have time for anything else. - Well, that's why they're pros. So it's their job, right? That's what they do. So yeah, your hypertrophy. Strength training programming is somewhat complicated, right, because of, it's not the danger, but you're going to have to pay, one way or the other, right? The risk is a little bit higher 'cause the load's higher and you have to be a little bit more technically proficient. When it comes to hypertrophy training, the way I like

to explain it is it's kind of idiot-proof. The programming is idiot-proof, the work is hard though. So here's your range. Anywhere between five reps and 30. Can you hit somewhere in there, perfect, it's all equally effective, you can't screw that up. The only caveat for hypertrophy is you have to take it to muscular failure. - And you need enough rest for the adaptation and protein synthesis to occur. - Yep. - Yeah. - And if you recover faster, you can maybe do it more frequently. And if you don't, maybe less frequently. - By that logic, should people perhaps experiment and figure out what repetition range allows them to recover, in concert with the training frequency that they can do consistently. - My recommendation is I think you should actually set your, use the repetition range as a way to have some variation, because most people don't want to go in the gym to do three sets of 10. They're going to get very bored very quickly. And so I think you should actually intentionally change the rep schemes for simple sake of having more fun. It is a very different challenge. The mechanisms that are inducing hypertrophy are different, but there's only a maximum amount of growth that one can get, right? And so you have, as best we think it now, and some people actually will espouse that we know really clearly about the mechanisms of muscle hypertrophy, which we don't. It's still very much a guessing game, but the three most likely drivers are one, metabolic stress, two, mechanical tension, and then three, muscular damage. You don't have to have all three. One is sufficient. You can have a little bit of one or two, and you can cut it, so you get it to play here. We've already talked about the muscular damage. Again, it's very clear, more damage is not better. But it is somewhat a decent proxy, right? Like again, a little bit of soreness is good. Just don't get so sore it's compromising your total volume, right? Mechanical tension is kind of like strength. And this is why if you do even sets of five or eight, and you're kind of close to that strength range, you will gain a little bit of muscle. It's not optimal muscle gain, but you're going to gain some because everything in these, like physiology didn't cut off at four reps and then five reps is a different thing, right? It's always a blend, so think of it as like a fading curve. As you get closer to the end, it fades less effective. As you get closer to the middle, it's more effective. Anywhere between eight reps per set to 30, it's equally effective. Past 30, it's going to blend out. Past eight to five to four to three, it's going to blend, you know, lesser there. So metabolic stress is one, the damage is the other, or sorry, mechanical tension is the one that's heavy. Muscle damage is the other one. The third one is metabolic stress. And this is, again, a bit of an area of scientific contention, but something's there. I know something's there. We're just kind of fumbling to figure out what exactly it is. And this is, metabolic stress is

the burn, right? It's there. It's why blood flow restriction training probably works. That's done very light, so there's no mechanical tension, there's very little damage, but somehow it induces a good amount of hypertrophy. - [Andrew] Very painful. - Oh boy. - I tried this. I have a friend, former special operator who lives out on the East Coast and took me through a blood flow restriction training protocol in a park. And I don't think I actually cried, but. - You probably did. - But I might've cried out once or twice. It was unbelievable, especially the lower body movements. Now it was a humid day, I'll claim a little bit of jet lag, but - No, no. - it was brutal. It was really brutal. And I also- - Do it on the best day of your life, and it's still brutal. - Okay, well, - Still brutal. - that makes me feel a little bit better. It was intense, and people should know that it is important to use the proper cuffs for these things. I don't have any relationship to any of the companies that sell these cuffs. But the reason is that you actually need to block particular avenues of blood flow. You can't simply cinch off a muscle. You can't tourniquet a muscle and train. - Not a good idea. - You can actually kill yourself that way. - Yeah, you can get a blood clot. - Yeah. And so if you're interested in blood flow restriction training, I imagine you have some content about this, or will at some point, but also there are resources online that people can look up. A question about hypertrophy training I think. Many people are wondering about train to failure, or don't train to failure. Assuming good form. - Yeah, okay, assuming good form, great. The answer is both. So you want to train to failure, but you don't need to go to extreme failure. So you don't need to necessarily go to that like, a partner has to lift the barbell off my chest. But you have to get close. You have to drive either heavy, stress damage, right, or pump. And so a really easy practical way to think about this. I heard Mike Israetel, who runs a company called Renaissance Periodization, years ago, outlined this at a NSCA talk. And it was beautiful, and I thought this is the most eloquent way to explain the context about training for hypertrophy. So I want you to look for three things in your workout, and let's say that you want a particular muscle to grow. Let's say you want your glutes to get larger. Okay. When you're doing your glute exercises, number one, are you feeling the glute contract? Okay, it doesn't have to be there, but that's a good sign if it is. Okay, let's say I didn't really feel my glute contract. I felt it more in my quads or my back. Okay. Did you feel a big pump afterwards? No, I didn't really feel a pump there either wards or during. Okay, great. Number three. Next day, did you feel a little bit of soreness there at all? No, I didn't. Well, that's a very good indicator, you didn't feel it during the workout, you felt no sort of pump, and it didn't get sore. Don't expect much growth. Didn't happen. - You distributed the

work across a bunch of muscle groups. - Most likely other muscle groups were too involved, right, especially if you're like, no, but man, my back got really. Well that's a really good indication of telling you what the hell was moving. And so in terms of targets, if you were to put, again, a one to 10 scale, how much should I feel it burning during? Anything less than a three, okay, it's probably not doing much, right? But it doesn't, like seven is not, a 10 is not better than seven. You need to feel it, but it doesn't have to be like, oh my gosh, I'm dying here. Soreness, same barometer, right? So if you can get like three, three and three, you're probably in a pretty good spot. Five, five, and five is maybe better, but you don't need to go much past that. So I want you to feel the muscle group either working, or if you're like I didn't feel it much, I didn't really get a pump but the next day it got really sore, well then you're still on a good path. Again, really sore isn't like ooh, a little tender, but next day it's okay. Day after that, I could train, no problem. That's really what you want to go after. And in terms of understanding, is this likely to produce some growth or not? - Excellent, excellent. Very clear parameters and recommendations I know are benefiting me, and will benefit a lot of people. If you'd be willing to throw out a few sort of sets and rep parameters that could act as broad guidelines for people who want to explore further. I realize that with all these modifiable variables, that there's no one size fits all for strength. I love this five to 30 for hypertrophy, that's a pretty vital thing. I don't think I've ever done a 30 rep set of anything. But now that you've thrown that out there, I see it as a bit of a challenge. - You want to know what's awesome about 30? You're going to get an insane pump. You're going to burn like crazy. But you won't get super sore. Because the mechanical tension's so low. It's so light. So you can get away with those things and you, it's hard because your mind is going to wander. You're going to get it like rep 20, and you're going to be like I'm done, and you're like no, there's a lot left here to get to 30. Where like a set of 10 is much easier, you're just like, okay, two more, two more. Set of 30's like, I got 16 more. It's awful, but you're not- - Just the counting is work. - It's terrible, right, and people tend to just kind of like check out. So 30 is possible, but a little bit extreme. But I would recommend all of 'em. Like it's a really fun play, you can do different, in the same workout too, by the way. Like you could do one set of 10 pushups and then take a little break and then do a set of 25. You can mix and match these things. There's no magic recipe that has to happen for all those, or do it different.

01:08:50 Tools: Protocols for Strength Training, the 3 by 5 Concept

So Mondays are my sets of 10 days. Wednesdays are my set of 20 days. And Fridays are my set of 30 days. And you can have all kinds of fun there, and it's hard to screw up. - Great. I love, that phrase is always reassuring. So for strength, is there a sets and reps protocol that is pretty surefire? - So a way to just think about a really fast answer for power, well speed, power and strength, is what I just call the three to five concept. All right? So pick three to five exercises. If you're feeling better that day, choose on the higher end. If you're feeling less that day, or you have a shorter timeframe to train, go less. So this would be three sets, or three exercises rather, or five exercises the most. So three to five exercises. Do three to five reps, three to five sets, take three to five minutes rest in between, and do it three to five times a week. So that can be as little as three sets of three, for three exercises, three times a week. That's a 20 minute workout, three times a week. It can be as high as five sets of five for five exercises, five days a week. So it's very broad and allows people to still stay within the domains of strength and power, while still being able to move and contour towards their lifestyle and soreness and time and all those things. The only differentiator to pay attention to between power and strength, is intensity. So if you want strength, this is now 85% plus of your max, right? And if you want power, it needs to be a lot lighter, 'cause you need to move more towards the velocity end of the spectrum, because power is strength multiplied by speed. So while getting stronger by definition can help power, you probably want to spend more of your time in the 40% to 70% range, like plus or minus. So that's it. Both of them, conceptually they'll work, everything else, the exercise, the reps, the frequency, all that can be still in the three to five range. Just change the intensity, depending on which outcome you want.

01:10:48 Mind-Muscle Connection

- The nervous system obviously plays an important role at the level of nerves controlling the contraction of muscle fibers. But of course, we have these upper motor neurons, which are the ones that reside in our brain, that control the lower motor neurons, that control muscle. And this takes us into the realm of where the mind is at during a particular movement. And to me, this is not an abstract thing. I can imagine doing workouts that are mainly focused on strength, or mainly focused on hypertrophy, and in the case of strength, am I trying to move weights, and when I'm trying to generate

hypertrophy, am I trying to, quote unquote, challenge muscles? In other words, if I'm just trying to move a weight away from my body, you know, pushing a bench press or an overhead press, I don't know that I want my mind thinking about the contraction of my medial delts. I think I want my mind in getting the weight overhead with the best proper form. Best, excuse me, and proper form. And certainly with hypertrophy training, best and proper form is going to be the target as well. But that simple, or I should say subtle mental shift, changes the patterns of nerve fiber recruitment. So can we say to get stronger focus on moving weights, still with proper form and safely, and to get hypertrophy focused on challenging muscles, still with proper form and safely. - It's very fair. Yeah, as a snapshot answer, it is a very fair thing to think about. Intentionality matters for both. In other words, if you look at some interesting science that's been done on power development and speed development, the intent to move is actually more important than the actual movement velocity. So if you're doing say something for power or strength, and you're doing just enough to get the bar up, that will result in less improvements in strength than even if you're moving at the exact same speed, but you're intending to move faster. And this is one of the reasons why good coaching matters. So if you're coaching an athlete through a power workout especially, and they're doing enough to just lift 50% of their one rep at max, it's not going to generate as much speed development as them trying to move that bar as fast as they can, even if the net result is the same barbell velocity. Turns out nerves matter. - That's a, I mean I was about to say amazing, but as a neuroscientist, if I say amazing that nerves matter. What's amazing to me is, if I understand correctly, what you're saying is that even if the bar is moving at the same speed, same weight, if my internal representation, my thoughts are, I'm trying to move this as fast as possible, versus I'm just trying to get the bar away from me, and get the weight up, I'm going to get different outcomes. - Yep, this is quality of work, right? This is, did you do enough to just check off a box or did you actually strive for adaptation, right? Similar concept actually works for hypertrophy, in terms of there is a handful of very recent studies that have looked at what we'll call the mind muscle connection. And this is doing things like imagine a bicep curl, and you're simply looking at and watching your biceps, and you're thinking about contracting it harder. Even though you execute the same repetitions at the same exact intensity, initial indications are the mind body connection are going to result in more growth than not. - You just gave authorization for people to look at their muscles - Please do. - contracting in the gym. - Please do. - Oh my. - Yeah, of course, right? - But the selfie is still ruled out. - I'd

rather you look at your muscles in your phone. So I'm fine with it. Those are initial. We don't have a large depth of research to support that. And maybe some stuff will come and counter it. But it does, it matches what folks in that community have been saying for a very long time, right? There's actually some stuff on simply flexing in between. So if you've ever seen a body builder, they'll do their set of bicep curls and then they'll get out and they'll flex and they'll check. And they're literally, this is what Arnold did, right? This is, if you go back to pumping in iron. - Or college weight rooms, I should say. - Right. - And for some reason there's something about that age group. - Yeah. - That there's a lot of checking of biceps in college weight rooms, for reasons that escape me. - If you ever interact with my wife, like she will be the first to tell you, I cannot walk past the mirror without like, I'm checking something out. - That you can't, - I can't. - or that she can't? - I can't. - Okay. - Not her me. - Got it. - [Andy] Like I'm the one that cannot walk past. - All right, well then I'll be careful not to disparage- - It has nothing to do with the hypertrophy, but I just like I'm a muscle guy, so I'm always like thinking and tinkering, or whatever. But yeah, it is, I think it's very much worth your time to do a higher quality training session. Be more intentional, be present, than just executing the same exact workout. I think that's globally very clear to be to your advantage. So if you're thinking like, I'm going to, like, I don't want to work out today. I got all this going on, or I'm tired or whatever, I'm just going to do the workout I know and get through it. Okay. If you can go, you know what though, like, I'm going to cut 15 minutes out of this thing. I'm going to get my head right. I'm going to go get two 20 minutes of quality work done, that's your best option by far. - You alluded to the fact that even just looking at a particular muscle might benefit in terms of the number of fibers you can recruit, or its potential for hypertrophy. I've heard before, and I certainly have experienced that muscles that for whatever reason, genetics or sports that one played, et cetera,

01:16:16 Mental Awareness

muscles that we find that we can contract to the point of almost a slightly painful contraction, seem to grow more readily than muscles that we can't recruit very easily. - [Andy] Yeah. - And the reason I mentioned sports that we played earlier is, I mean, you just have to watch the Olympics to see that, swimmers obviously are very good at engaging their lats. You look at the gymnasts, they seem to be very good at engaging everything. - Yeah. - And they go through a huge number of different dynamic

movements, so that explains that. So I find that, you know, if people say, oh I can't get stronger in this, or my whatever body part is weak, in terms of its inability to engage hypertrophy. - Yeah, I see where you're going. - That oftentimes that can be because of an inability to engage those upper motor neurons, to deliberately isolate those muscles. Are there ways that people can learn to engage particular muscle groups more effectively over time, for sake of hypertrophy or strength, or for cases of trying to overcome injury potential or injury, because imbalances are bad across the board. - Yeah, this is actually very common, and I think everyone has probably gone through this. There's some part that you just can't get going, for me, that was the lats. That was the rhomboids. So my back muscles. For years, I couldn't activate my lats or my rhomboids. These are the muscle groups that connect your shoulder blades. So if you try to squeeze your shoulder blades together, that set of muscles there are called your rhomboids. Your lats of course are more vertical and pull you kind of up and down. And no matter how many lat pull downs I did, bent rows, pull ups, I could never see any development there. No increase in strength. And it took me probably a decade to figure out how the hell do I actually get these things on. In fact, if you'd have asked me, even in my college years as a college football player, hey flex your lats, like show me your lats, you would've seen no movement there. When I was doing a pull up, in that particular case, the only way I could get the bar to move was by using my biceps, right? So it's a synergist muscle, it's supposed to be a secondary or tertiary muscle in that movement, but for me it was primer, because of my over strength in my biceps coupled with my lack of activation in the lats. So you're compensating the same movement. Actually kind of an easy way to think about this is imagine doing a bent row. So imagine you're bent over kind of at a 45 degree or a horizontal angle, and you're going to pull a barbell to your belly button, right? Now you can actually do that exact same movement with very little back muscle activation, by simply flexing your elbows more. And so you think the barbell's going all the way down, it's coming all the way up to touching my belly. And you think you're doing a great back development exercise. When in fact, because of the way that you're executing the movement, you're getting very little back development. And this is a really good example of why someone has done a specific exercise many, many, many times, but yet failed to see development in a muscle group. Which goes back to earlier part of our conversation, which is why exercises themselves do not determine the adaptation. It's the execution that matters, right? It's the technique, it's the rep range, all of those are going to determine your actual result. So if anytime you're banging your head against the

wall and thinking like why am I not getting movement here, growth or strength or whatever, it's almost one of those, it's guaranteed to be one of those areas, right? You're probably not getting the muscle groups to activate. In that particular example, just because we're here, try imagine doing that bent row. Instead of pulling the barbell to your belly, squeeze your shoulder blades together first, as far as they can possibly go, and then bring your elbows up without changing the angle of your elbow. So in other words, without bringing your hand closer to your shoulder. So keep that same angle and come up as high as you possibly can, and then finish out the movement. That's going to guarantee a utilization first of the back muscles and a finishing with the biceps at the end, which is how that movement is supposed to go. So how do you coach into that? Well, it can be a number of things. Whenever I'm diagnosing movement quality, I look for a handful of things, but very first one is awareness. You'd be surprised how many folks, when you just simply tell them that muscle group right there, and maybe you give 'em a tactical prompt, so you touch it, or you put something against it. This is actually why, sorry I'm jumping all over the place, but this is why things like a belt work very well for actually increasing abdominal strength. So a misconception out there is if you wear like a belt when you're lifting, then the belt kind of does all the work for you and your abs get weaker. That can happen, but the exact opposite can happen as well. So if you take a belt, for example, and you cinch it down really tight, and then you just completely disregard your midsection, you will see a loss of strength in your midsection because now the belt is doing the work. But if you put the belt on just a little bit, kind of tight, to where you get some sensory feedback, and you think about using that belt as a way to activate the core musculature, you will actually see a higher, if we look at like EMG activation, the core muscles would be activated higher, to a greater extent, than when the belt is off. - [Andrew] Because of proprioceptive feedback. - Hundred percent. - And for those that are wondering what proprioceptive feedback is. Proprioceptive feedback is that there are nerves that extend out to the muscles that control muscle contractions, but then there are sensory inputs from the skin and muscle that go back into the nervous system, and those work in concert, and that feedback is proprioceptive. I think it literally translates to a knowledge of where one's limbs are, and what's happening on those limbs. - In space, yeah. - I've seen, I don't have a training partner, but I've seen in gyms where someone will be training and someone will tap the muscle of the person who's doing the work, in order, this is consensual tapping of other people's muscles, not walking around - Please. - touching people's muscles, please. That to provide that

proprioceptive feedback, so that the person doing the exercises becomes more aware of the muscle that they're supposed to be training. And it seems that that's probably an effective practice. - Yeah. I'll give you two examples. I'll go to the back with that pulling movement, but then I'll stay in the belt really quickly. So a very easy example that you can do right now, listening, and I learned this from Brian McKenzie, our mutual friend, right? So if you take your hands and open 'em up, like you make an L with both your hands, and now take those and put 'em around your waist, just above your hip bones. Now what I want you to do is press out as hard as you can on your hands with your core. And you can feel a lot of core activation. And most people think core activation is the front of your stomach, right? Your six pack. What you need to do is create a cylinder around your back. So it's the front, it's the side, and it's the back. So if you take your two fingers, point them. Now put them just outside your belly button. Can you move your fingers by just moving your ab muscles? 90% of people can do yes. Same exact thing. Now go to that same position, just above what's called your ASIS, so your anterior superior iliac spine, right up that front of your hip bone, right in the front. Can you now move? Great, 50% of people are not going to get any movement there. - Really? - Take your thumb and go right above your PSIS. - My what? - PSIS. Posterior superior iliac spine. - Okay. - Right, now can you move? Most likely no. - Sort of if I do a mini low back extension. - Don't. Just with your core musculature. - Barely. - [Andy] Yeah. - Maybe- - 90% of people can't. If you can't perform that contraction, you can't stabilize your spine. So only way to get stabilization in your spine is then to go through hyper-extension. And now that's a compression strategy you're putting on your spine. It's better than rounding your back, like in going forward, but over-extension is not great either. So you want to be able to flex the musculature in a cylindric fashion, so you have control. So if you go back to our very first thing, and with your hands open, and you put 'em right here, and if you're like I can't get activation, if you pay attention to your thumb, right? Now, just move your thumb. And now you see activation back there, fight? - Mm-hmm. - Boom. Now if you can imagine turning that on just a little bit, and now notice how I can do this, by the way, at the same time I'm talking. If you have to go [gasping] we don't have control, right? So you have to be able to separate breath from brace. So now, if I can put myself in a position, and Kelly Starrett has always said 20%. Give me 20% activation here, and now I can squat, I can hinge, I can jump. I don't need to be locked down to a hundred percent scream to be able to brace my spine. It's going to be ineffective and wasteful. I want to be here. Well, a belt provides that proprioceptive feedback where I can put it on 20%,

and it just is a reminder, if I don't press against the belt, the belt slides and falls down a little bit, 'cause it's not on super tight. If it's on so dang tight, it's doing the work, and I forget. So we just want a little bit of feedback there. Same thing with your upper back. If you're having a difficult time activating those rhomboids or those lats, someone can do a simple thing where they take their finger, put it right between your shoulder blades, and you just tell them things like hey, squeeze my finger. Squeeze my finger. As you're doing your bent row, or your pull down, you can touch the lat. You can do just visualization stuff. So just imagine like a 3D rendering of that muscle group, and you're watching that muscle group contract. It's very powerful, and very effective to do it. So a touch, a visual, all this stuff can help, get people to activate. Outside of simple awareness, typically eccentric overload is a very effective way for activation of a difficult to target muscle. - So the lowering of the bar, or the lowering of the weight. - The movement of the weight away from the body. It's not necessarily was lowering. 'Cause that kind of depends on what muscle group - Right, sure. - you're doing, right? - [Andrew] I misspoke, yeah. - Things like a pull up. Okay, so if I'm going to do a pull up and I have poor lat activation, I can still get the pull up muscle movement executed by contraction of the biceps and things like that. However, to make the movement simpler, I'm going to go all the way to the top. So imagine stepping on a box or something going all the way to that top of that pull up position. And starting from there, and I want you to simply lower it under control. And so you're just simply breaking the movement down into smaller pieces, that allow you to focus on the execution more. It's going to be great, eccentrics are great for strength development, very good for hypertrophy, and allow you to focus on control. I'm willing to bet a huge percentage of you out there who're like I've never had a sore lat, you know, I've done a lot of pull ups and things like that, if you do that eccentric only you'll probably wake up the next day going, oh gosh, I feel it there. And that's a sign, even if you didn't feel it in the workout, but it got a little sore the next day, keep down that path. And then eventually you'd be able to do a concentric, maybe take a break. Maybe do an isometric, where you just hold that position. And eventually work that into a progression where you can do the concentric, eccentric, and isometric portions, and get activation. So that might take you six weeks. May take you six months. But that's generally a pretty good strategy for learning how to activate a muscle group. - Terrific suggestions. Is it true that eccentric emphasized movements might require a little bit longer recovery, or they lead to more soreness than - They can. - concentric movements? - Yeah, they typically can, but they're also higher force output. So very

good for strength development. But they're going to lead on average to more soreness. So more potential for intracellular disruption that is going to be associated with pain. There's not as much, people like to explain muscle soreness as a result of microtrauma and micro tears in the muscle. And that can happen, but that's not the norm. Most of the time, it is things like disruption of calcium that's going to lead to excessive swelling, excessive pressure, and that's going to be then translated as extreme pain. So that's probably explaining more muscle soreness than actually microtrauma.

01:27:57 Breathing Tools for Resistance Training & Post-Training

- Terrific. I was going to get to breathing later, but maybe just for now, if we can do a brief little foray into breathing, as it relates to weight training. Is there a prescriptive for how to breathe during resistance training? Here I'm thinking with weights, not necessarily body weight, only movements, although I suppose it could be, that applies 75% of the time to 75% of the people. What I was taught, and I'm hoping you're going to tell me this was wrong, 'cause then there might be more benefits awaiting me, is that I should exhale on the effort and inhale on the lesser effort portion of an exercise. Is that true? Is there a better way to breathe? - There is a better way to think about it. So number one, if you can breathe and brace, then this conversation goes away. So if you can maintain intramuscular, intra-abdominal pressure while breathing, then I don't really care when you breathe. Very challenging to do at very heavy weights. If we flag this on two areas of a paradigm. Paradigm one over here, you're going to do a set of 30, and you're going to do front squats where a barbell is sitting on your throat. If you don't take a breath, like this is going to end one way and one way only. You passing out. Clearly has to be some breathing strategy. The other end of the spectrum is let's say you're going to do a vertical jump. You don't need any amount of breath there, it's never going to happen, right? The question is, what about in the middle? Right? So I'm doing some sort of strength training there. Well, number one, make sure you're braced and then you can get away with less need to worry about it. In general, a decent strategy is to maintain a breath hold during the lowering, or eccentric, or most dangerous part of the movement, and then you can exhale on the concentric portion. So if the bench presses are example, if you held in, braced, lowered it under control, and now started the concentric pushing away force, and then you wanted to take an expiration, during the last half of the concentric portion, that's an okay strategy. If you're going to do a single

rep, you don't need to worry about it. You can just avoid or omit breathing entirely. You're going to be just fine. If you're doing more than that, especially three to four to five to seven, eight, you're going to have to have some breathing strategy. A very common one is probably every third breath I'm going to do like [gasping], exhale on the third. Reset and re-breathe. Something like that. If you feel like you need to breathe after every one, that's okay, but it's going to get wasteful, 'cause you have to take time in between reps of sitting there. If it's a squat, that's different, versus a deadlift, if you're resting at the bottom. So there is a little bit of game here. So in general though, is that 75, 75 kind of really thrown out, you threw out. Breathe in, do the lowering, and exhale on the out. If you have to less reps, don't worry about it. More reps, then you need to come up with some sort of breathing strategy. - How about breathing in between sets, and maybe even after the workout? - Yeah. - This is something I think a lot of people overlook, like and because the, it is the case that recovery has to do both with the specific activation and to muscles, and the nervous system, but also the attacks on the nervous system can also take place between sets. I mean, if you're really geared up between sets and you get adrenaline, you know, as high in between sets or close to it as you are during your sets, you can imagine that the recovery would take longer. Or at least that you're not spending adrenaline in the most efficient way, if there is such a thing. - Yeah, fair. You're not going to see any athlete that I work with just breathe in between. Whether it's in between innings or in between rounds, every single one of them's going to go back, sit in the stool, and they're going to immediately be into a breathing routine. A very intentional one. They're a little bit different for every athlete, depending on the sport. Even a PGA golfer, there's going to be a, we just hit our ball, we're moving to the next one, we're going to go into our breathing strategy. Every one of 'em. It's a huge area of potential benefit and consequence, if you're just ignoring it. In general, we want to do any sort of calming breath, we want to restore. It depends on what we're combating. Are we combating low oxygen or high CO2? So that strategy is going to be a little bit different. But in general, that is a huge time opportunity to get better. In fact, people can go back and listen to some of your earlier episodes where you talked about, well you have spoken about, I think, on this show, when neuroplasticity works, and if you're losing that opportunity, post-exercise, you're leaving gains on the table if you will. So not only are you going to see the athletes that I work with mostly have a breathing strategy in competition. We're not going to just finish a workout, high five, drink water, and walk out of the gym. There will be a down regulation strategy that

is heavily involved with some sort of light control, as well as breath control. The individual prescription on that, there's a ton of variation with what you can do. The easiest thing is do something that calms you down. Most likely that's going to be moved towards as much nasal breathing as you can possibly do. And a really easy rule of thumb is a double exhale length relative to inhale. So if you need to take a like four second inhale, double that time and breathe out for eight seconds. Box breathing is fine. So equal inhale, equal hold, equal exhale, equal hold. So four second inhale, four second hold, et cetera, et cetera. A triangle is fine too. There's a lot of ways, you can get really complicated, like what Brian McKenzie will do, and Rob, and those guys have, you can get all kinds of systems for inhale exhale control and it can be optimized. But some strategy of calm. We're going to almost always put you on your back or close, and then we're going to cover light. We can do some, like we've done actually a number of musical interventions as well, but you can just as simple as sit down in a locker room if you have to, and just breathe for five minutes. That alone is going to be productive. - That's great. If you're breathing in the locker room for five minutes, I suggest closing your eyes, or you get some funny looks, and if, you'll still get funny looks, but you won't see people looking at you. - Yeah, exactly. - I love this, and I started doing this because you and Brian McKenzie informed me about this, and it completely changed the rate of recovery for me. I realized that I was leaving workouts, both endurance workouts and strength hypertrophy workouts feeling great, but looking at my phone, getting right into email and meetings. - Ooh, ooh, rough, - Not concentrating on my breathing. And all I did was to introduce a, on your recommendation, a five minute down regulation. So exhale emphasized breathing, a bunch of different varieties, physiological size, box breathing, exhale emphasized, twice as long as the inhale component for five minutes. And I noticed two things. One, I recovered more quickly, workout to workout, no question about it. - [Andy] Yeah. - The numbers told me that. And the other is that I used to have this dip in energy that would occur three or four hours after a hard workout. And I always thought that had to do with the fact that I'd generally eaten a meal at some point post-workout. Turns out it wasn't the meal at all. - Yeah. - It's that adrenaline ramp up during the workouts, I wasn't clamping that at the end. And so I think eventually it's crashed, and then three or four hours later I'm having a hard time even reading what's on the screen on my computer, thinking maybe it's the screen. Maybe it was what I ate for lunch. Turns out, the down regulations allowed me to work through the afternoon with no issues whatsoever. It's really been quite powerful, and so I'm grateful to you for that. And

I think this is something that I think 98% of people are not doing, and it's only five minutes. - You don't even have to do five. Give me three. If you really have to push it, give me three. And you can even do this, you can save time. You can do this in the shower if you have to. So you're done, you're finished. Drink of water, whatever has to be, and you're getting in a shower, you're getting ready. Just give me three minutes in the shower. It's not ideal, but as little as that, it can pay huge dividends. You need some sort of internal signal that we're safe. Like throttle down here, we're going to move on. That has to happen. I could go on and on here, but I think we're making the same point kind of over and over again. It's a big deal and do it. - Yeah, and you're saving energy. I mean, the energy here is neural energy. I think fighters do this, good fighters learn to do this between rounds. Sprinters learn to do this between events. I think humans should learn how to do this between any, you know, sort of interval type activity, including work, social engagement. - Yeah, I was going to say- - I mean, this is such a powerful tool. - Do this for one minute, after every important, whether it's an individual high volatile interaction, or if it's a, you just did a nice 45 minute sprint to work and you're deep into it or whatever, fine. Just gimme one minute. Set your alarm, just one minute, and that also will pay dividends. - I love it, and as I said, it's made a outsize different, positive difference on my training, but also activities outside my training. Which is, for me, I'm not a professional athlete, I train for health and 'cause I enjoy it, but when a really hard workout starts to interfere with the ability to do the other things in life, - Of course. - that's not a good situation. So this is really terrific. There's a lot more in each of those categories of strength and hypertrophy, but you've given us a tremendous amount

01:37:25 Endurance Training & Combining with Strength

of valuable information there. Maybe now would be a good time to shift to endurance, and of the four types of endurance, and maybe you could remind us what those are, what do you think are the two that most people are seeking or pursuing in terms of health and aesthetics, right? I realize that we probably have athletes out there as well, but when I think health and aesthetics, I think, okay, the ability to do sustained endurance, 30 plus minutes of some ongoing activity, how does one maximize that work? What are the modifiable variables? And then maybe you could tell us what the other major category is, that people ought to have in their kit. - Okay. So starting off with exercise choice. One thing, as soon as we cross into the endurance world, and this is

true for all four of those categories, exercise choice needs to be very concerned with eccentric landing, right? So you don't need to avoid it, but you need to recognize it, relative or compare it against those other strength and speed ones. The volume is low on those ones. So if you have some eccentric absorption it's okay. But as we sort of talked about five minutes ago, more eccentric means greater chance of muscle damage soreness. So if you take something and magnify it across 30 minutes, or even five minutes, but of maximum exertion, you have a recipe for blowing up. You can imagine I haven't run in forever, and I've just, I've listened to this "Huberman Lab Podcast" and I'm okay, I'm going to get into my zone two training, whatever. And I start jogging, I'm going to do, you know, I remember when I was, I used to be able to do 25, and you just do a 25 minute jog. The amount of eccentric landing that just occurred on every single step, because you're never, with running, even slow running, you never have two feet on the ground at the same time. So it is a one foot land, one foot land, your entire body mass plus gravity onto one leg at a time, repeated now hundreds of times. That eccentric landing is going to cause tremendous soreness. Your quads are going to go. You're probably going to get shin splints, which is what, this isn't, those are entirely caused by eccentric landing, and when the tissue is not ready to tolerate that. If you're not landing correctly, this is when knee pain happens, back pain, shoulder, neck pain, 'cause of movement compensation. So anytime we start pressing to fatigue, let's be very concerned with there. So my initial recommendation is, start with activities exercise choice-wise that are mostly concentric based. So think about a cycle. So when you're riding on a bike, you're pushing the pedal, but you're never landing and absorbing it. So you could go out and do a 45 minute bike ride, and you're not going to get that sore because there's not a lot of eccentric load. Swimming, similar thing here, right? There's some eccentrics when your hand hits the water, but fairly minimal. It's mostly a push push, push, push, push, no load. Rowing, similar thing. Mostly concentric. Pushing a sled is fantastic. Going uphill, running or even walking hard uphill, all good, 'cause they're very minimal landing relative to like running downhill, which would be a very, very bad idea to start. So if you're first jumping into these things, progress your volume for endurance very slowly, if it involves eccentric landing. A really bad strategy would be to jump in and do say circuit training class that involves a bunch of box jumps, right? This is not a good way to do your first foray into conditioning. You're going to get incredibly sore because you're jumping and landing. You're now looking at three to 10 X body weight in terms of absorption, with a single land, even if you're just jumping. So be careful of that,

in any of those endurance areas of exercise choice. So what to pick. Pick the one that you are most technically proficient in, because you're going to do it a lot. It's going to be a lot of repetitions. Whatever one you feel the most joy in. If that's rowing, great. If that's pushing a sled, it doesn't really matter. You can do this actually with weights. This is our preferred way, by the way, with our athletes. So we might do a 30 minute circuit where we do a five minute farmer's carry with a pretty light weight. So you're just going to carry some weights in your hand, and you're just going to walk up and down the street for five minutes. You're going to set that down and then you're going to do say a three minute plank, and then you're going to pick that up and you're going to do body weight squats. Like slowly and just tempo. And you're going to do a handful of different exercises, so the athletes don't get super bored. Or a very simple one, if a 30 minute workout, 10 minutes on a treadmill, 10 minutes on a bike, 10 minutes on a rower. But for those of you that are like oh my God, I can't do 30 straight minutes running, cool, break it up into three or four different exercises that are all fairly safe. So that's how I would do that long duration piece. - Got it. - For exercise choice. - And then in terms of heart rate during that period, I mean how much attention should we pay to this? The kind of very broad prescriptive I've thrown out on this podcast a few times, based on my read of the literature, is for most people that are oriented toward health, including people that are working on size and strength gains, hypertrophy and strength of course, that getting 150 to 180 minutes of so-called zone two cardio, - Yeah. - can just barely have a conversation, but if one were to push any harder, you wouldn't be able to, that kind of thing. It's just as a kind of a generic recommendation that almost everybody should follow, in order to just keep their cardiovascular system healthy. But I know there's a lot of nuance there, and some people would like to be able to run continuously for an hour at speed, right? - Yeah. - Obviously not sprinting. But what are some of the finer points on long distance endurance? And how often should one do it? - Okay. Frequency, you could do it as daily, right? - [Andrew] Even when doing strength and hypertrophy? - No question. - Well that, I think, is an important point for people to hear, 'cause a lot of people think that they are going to greatly diminish their strength and hypertrophy gains, as it's often called, by doing zone two cardio. - Zone two, you have almost no ability to block your hypertrophy. Zone two, truly, if it's really within that category, if you're talking about conversational pace, there is very, in fact there is strong reason to think that is not going to influence hypertrophy for the overwhelming majority of people. - It might even help it by increasing blood flow to the various- - Absolutely. - Does it matter? Let's say

someone's doing primarily strength and hypertrophy. Their primary goals are strength and hypertrophy. And then they're going to do, they're going to hit that 150 to 180 minutes of zone two cardio per week. Assuming they're breaking that up into three or four sessions. Does it matter if they do it in the same workout before or after? Does that matter? I tend to do, just by way of example for people, certainly I'm just one example. I tend to do resistance training one day, then I'll do zone two cardio the next day, I jog 'cause that's the thing I prefer. Then I'll do strength hypertrophy training the next day, and then, and jog for my zone two cardio. And then I take one full day off a week. I've never actually done the zone two cardio on the same day, but were I to do it on the same day, would it matter if I did it before or after my strength hypertrophy training? - Not really. - Okay. - You're going to be just fine. The interference effect is what this is called. So this is all the way back to 1980, Bob Hickman's stuff, right, and he was actually working in a lab with John Holloszy, who's one of the fathers of exercise biochemistry. And sort of the story goes that Hickman came in, he was the strength training guy, and Holloszy and almost all of those initial exercise physiologists were conditioning folks, right? So it's almost always swimmers and runners. And that's why a bulk of the exercise physiology, historically, is shaped in that direction. That's what those scientists were interested in. So Hickman was there in the lab, and then how much of this is myth or not who really knows, but so the story goes, that this is sort of chipping back and forth, and you know how from a PI to a postdoc, and kind of that razzing works a little bit. And eventually he was like you got to start running with us, and he was like you got to start lifting with me, and kind of goes back and forth. Well, you know who wins in that equation? It's not the postdoc, right? So it's, the PI gets in and says, Hickman says, okay fine. So he starts running with Holloszy and then eventually starts to realize I'm getting weak. I'm losing strength and like, I just can't. I think it was his bench press specifically was going down, or maybe his squat. I can't remember. Who knows if it's even real. But point is, so he's going along and so eventually that starts to create a little bit of animosity, and he's like actually I don't think this is good for me, and then blah, blah, blah. And so they did what any good scientists would do and said, well, let's find out, right? And so he run a really famous experiment where he took a group, three groups. One group did a endurance piece, right, the steady state cardio. One group did a strength training piece. And then the third group did both of those workouts combined. Not like a reduction, so both volumes stacked on top of each other. And the results are fairly predictable. In terms of the endurance group only had the greatest increases in

VO2 max and endurance markers. The strength training group had the greatest increases in muscle hypertrophy. But where the interesting part was, and where this whole field started, was the combined group. So this is concurrent training is what it's generally called. So you're doing concurrent things. And typically that means hypertrophy and strength stacked on top of some steady state endurance. - In the same timeframe. - Same workout. - Same two hour block. - [Andy] Or same like week. It doesn't really, it can be, - Got it. - kind of all these. Well, the concurrent group saw the same improvements in VO2 max as the endurance group. And he is like, well, okay. So the strength training did not compromise the endurance adaptations. However, they saw much lower increases in strength than hypertrophy. And so it was, the conclusion was, the addition of endurance work compromised muscle growth and strength development. However, the addition of strength training to your endurance work will not compromise your endurance gains. Now that second piece has been shown countless more times, right? So if you're an endurance athlete, adding strength training is almost always going to be massively beneficial. Very little chance of detriment. This is why every endurance athlete is going to have some sort of strength and power component to their training. The controversy though came in the interference effect. So how much endurance training really blocks muscular development. And for years, myself included, was we preached hard. Don't do these two things at the same time. My friend, my colleague, Kevin Murach has a really nice review article with Jimmy Bagley. Those two guys put this thing out, you can go read that, where they cover all these things, and they've got some nice figures in there. But the general answer here is interference effect is sort of real, but it's probably greatly overblown. It matters, so are you talking about a 20 minute jog at conversation pace? That's probably doing very little. With the assumption that are you doing an eccentric-based exercise like running? Well, then you're going to have more of an interference effect than cycling. That makes a ton of sense, if you think about it, right? What's your total energy intake? If you're eating sufficient calories, you can still be in an anabolic state. If the addition of extra energy expenditure, it's all it really is, the cardio, put you in a negative energy state, it's going to become very difficult to go through anabolism. So those things matter. If you're talking about doing like running a few laps around the track as a warmup, like that's not interference effect. What we're really talking about is a big volume performed consistently. Now after Hickman came out with this paper in 1980, people followed it up in the '90s and 2000s with mechanism. And we started to look and see, and we started to see, hey, there's this cell-signaling

pathway that goes down called mTOR, and that's what leads to muscle growth. And then on the other side of that equation, there's a thing called AMPK, which is more associated with mitochondrial biogenesis and endurance. And there's this little molecule in between at the time, most people would point to TSC2. Well, turns out AMPK activation is fine. If you activate mTOR, has no bearing on AMPK, but if you activate AMPK, it's going to activate TSC2, which inhibit mTOR. And so it was like we had practical outcome, i.e. Hickman. You're going to get weaker. Now we had mechanism. So that story became very, very strong that this interference effect, and this is how science should work, right. When you see mechanism match up with practical human outcome. It's a strong- - That's what you want. Yeah. - It was still wrong though. It just took more science, right? And this is why we always have to give science a bit of time, and you have to be willing to follow, right. And again, even me in the field who has a practitioner background and science, I felt very strongly, this is a big problem. It just didn't turn out to be the case. Enough studies came out where I'm like, okay, it's probably not that big a deal. Unless the movement is heavily eccentric-based, the volume is very high. You're trying to maximize muscle growth, and energy's not controlled. If that's not all the case, interference effect is probably not something most people should worry about. Especially when you compare that against the well-roundedness that you need for total physiological health. Probably not a big deal. - Very reassuring for me to hear, because I do enjoy lifting weights and I really enjoy running. And I love running outside. I believe I used to experience the interference effect when I used to do a very long run on Sundays. I would just go out for two hours or something like that. I don't know that I ate enough, or who knows. I always feel like I eat enough or more. I love to eat. But that long Sunday run always made it hard for me to make progressive gains in strength and hypertrophy in the gym. Whereas when I cut that to 30 minutes, three or four times a week, I don't see any interference effect at all. - Probably very real. - And I haven't trained specifically for endurance in a very long time, so I don't, I haven't experienced the non-interference effect, which as you said before, most, if not all endurance athletes probably are, or at least should be doing some sort of strength work, just to keep the undercarriage strong as I think- - Yeah, there's a bunch of reasons, but yeah.

01:51:20 Tools: Protocols for Endurance Training

- So what are some protocols that people could explore for continuous endurance

training? I mean, I've thrown out this 150 to 180 minute zone two cardio, but that's really the kind of kindergarten of endurance. - Yeah. - And there, I'm probably being generous. It's probably the nursery school of endurance that everyone should do. What sorts of other protocols, I realize that can be very goal-directed, but is it unreasonable, for instance, for somebody to do four hours of continuous endurance training with intervals in there as well, to get it kind of all around heart health and the ability to go long distances? - Yeah, I'll answer this two ways. The very first one. To tackle the long duration endurance is, how I refer to it. You asked earlier about heart rate zones. To me, that's almost totally irrelevant. It doesn't matter, right? If you're moving, you're moving. That's the functional piece here. If you want to push it and go at a non-conversational pace, that has tremendous health benefits. If you want to do it a little bit slower, fine. If you're at the pace where you can have a conversation to me, I don't even count that as exercise. That's not a pejorative, by the way. That is just general physical movement. And it is extraordinarily clear, you need a lot of that. You need a lot more of that than we get. You can do this in a couple of efficient ways. Just taking your phone calls moving. If you've got a 30 minute call every day, or most days of the week, and you can do that while moving, you've checked not that whole box, but a pretty good chunk of it. - And that could even be done inside, - 100%. - if you're pacing back and forth. I'm a big pacer. - The, yeah, me too. Like you probably saw me, like I'm going to walk up and down all over the place. Most of the time, when I'm in my office working, like I'm shadow boxing, like I'm doing air squats, not even intentionally, I'm just like. - Do you have one of those treadmills under the desk? - I don't. But like every lab I ever came through, somebody did. - We did an episode on workspace optimization, and the data on those treadmills are pretty interesting. They definitely increase alertness, which for obvious reasons, even a little bit of movement is going to generate - No doubt. - a little bit of adrenaline. So pacing around, moving, taking calls moving, getting walks when you can. And then in terms of building endurance, let's say somebody wants to quote unquote, get into better shape. - Yeah. - They already, may or may not already have some size and strength that they're happy with. And they just want to get, they want to improve their health. - Yeah. So I can- - When does that 150, 180 thing tick over into a different protocol? - Yeah, okay, so I think the way that I can outline a weekly schedule, just as a conceptual model here. That long duration stuff is not even counting, as I mentioned, right? It's just a, this is what you need to do as a human, moving forward. We haven't improved. If you're extremely unfit, you may see some changes in cardiovascular health there, but for the

most part, this is just knocking out the general physical practice, you need to be higher functioning. So whatever that time domain is, I don't really care. It's not a huge concern of mine. What I think you need to hit are these nodes. You need to do something once a week, that gets you to a maximum heart rate. Now I don't have to literally mean max but close. - So this means really sucking for air. - Really, like as high as you can possibly get. You can wear a heart rate monitor if you want. But maximum heart rate, the rough equation we say is 220 minus your age. So if you're 40 years old, your maximum heart rate is probably about 180 beats per minute. Now I can tell you flat out right now, my max heart rate is close to 210, which means I'm 10-years-old. So take that number with a grain of salt. I have had a bunch of professional athletes who are in their 20s, and their max heart rate's 175. And they are in way better shape than I am. So maximum heart rate is not a good proxy for physical fitness. It's a rough number. An easy way to do it is if you have a heart rate monitor or anything like that, do the hardest workout you can possibly do, see what the highest number you get is, and assume that's close. If you want to just start at 220 minus your age, that's fine too. Do something though where you're like, yep, this is death. Like this is really, really challenging. - For how long? - However long that takes you. That can be a 30 second go on an Airdyne or Air Assault bike. That could be a, do one of those things where you kind of like sprint, run as hard as you can during the straightaway on a track, and then walk the corners. Kind of an old classic, when you and I were kids, interval training. - They don't do that anymore. - I guess, I don't know, I don't hear anybody talk about it. - In PE class we had to change, and if you didn't bring running shoes, you had to do it barefoot. - Oh, I love it! I love your teacher. - Yeah, it wasn't a, our football, basketball, baseball teams weren't that good, but anything like running cross country, just 'cause of where I grew up. - Oh yeah. - We had brutal coaches. So yeah, they'd make all kids do these runs. - Yeah, so it can be in the 30 probably seconds at a minimum. It's hard to get you to a true heart rate max in shorter than 30 seconds. You can get to total suck in under 20 seconds, but getting to a true heart rate max is probably going to take more than 30 seconds. So it doesn't really matter what you want to do. It can be, again, a sprint uphill. It could be, we were talking, it could be burpees to death. You know like, whatever you want to do, just- - Although those have an eccentric component, right? - Yeah, they do. No question about it. But if you did- - Not to actual death, by the way. - If you just did I'm going to do as many burpees as I can for 90 seconds, it probably won't take you much longer than that to get close to max workout. - And is that the whole workout? - [Andy] Could be. - So once a

week, get to max heart rate. - Touch it. - I love it. - Touch it. It's not the best, but it'll work. - And what are the specific benefits that that provides? - Okay, so earlier in our chat, we outlined the rule of specificity. Specific adaptation to impose to man. If you're never getting to that high of a pace, you're never, it would be like trying to get stronger, but only going to 60% So every cardiovascular adaptation that occurs with cardiovascular training, is just simply going to get to the top end by doing this. So if you just start at the heart itself. Stroke volume increases. So this is the amount of blood that's kicked out per contraction. Cardiac output. Resting heart rate. If you go to the endothelial function, you're talking about nitric oxide release. Endothelial health in general. Capillary, mitochondria, all the way down. Like you just walk through the whole system. Pulmonary exchange to the lungs. All of those are going to benefit by being challenged to their maximum. - They also teach you where your vomit reflex is. - Yeah, there you go. Right. - Let's hope not. - Stress is what causes adaptation, right? So if you push your, okay, here's the difference. If you did 25 minutes of steady state, you're not challenging the same thing as what we just talked about. The way that I explain this is if you understand the point of physiological failure, then you understand the place of adaptation. That's it. So if you and I both go run on a, we both did a VO2 max test. So a classic VO2 max test is going to take eight to 12 minutes, and it's going to look something like this. We're going to get on a treadmill, and we're going to run. And every minute I'm going to just slightly increase that treadmill, either the speed or the grade. Most of the time, it's the speed, right? So we get to a high grade, say 10% grade or something, and then we go five miles per hour, 5.2, 5.4, 5., and we just go until you can't go any longer. Now let's say you and I did that, and we had the same exact timeframe, and so we both went eight minutes. The time that you last is not the thing that we care about, right? It's the volume of oxygen that you breathe out is what determines it. So let's say we had the same time domain and we had the same VO2 max. Let's say they were both 50 milliliters per kilogram per minute, which is like a okay number, but that's nothing to be extremely proud about. Just because we have the same number does not mean we have the same point of physiological failure. And this matters because it's going to answer the what do I do about it then question, right? So if you got off and I started asking you a series of questions, and you're like, and I basically said why'd you quit? Why did you jump off the treadmill, why'd you stop? And you were like my chest, like I couldn't catch my breath. I thought my heart was going to explode. Okay, great. If you ask me and I said my legs were on fire, like I was breathing hard but I couldn't take another step, this is a very

rough indicator of different places of physiological disruption. Now what I've seen a lot with my professional athletes, especially like fighters. They're going to generally fail on their legs, because they don't often do a lot of strength training in their legs. They don't do a lot of leg work. They're fighting on their back, literally, a lot, or on top, or on their knees. So their legs tend to give out before there. Someone who fails in the cardiovascular system, like say you did a lot of leg training, typically like an endurance athlete who's, that's not going to be their issue. It's just going to be they're going to reach a heart rate and ventilation threshold that they can no longer handle. If I put you on the exact same training protocols, it's not going to be as effective because you're going to always fail at your legs and they're going to always fail at their cardiovascular system. I need to flip that, right? I need to put you in a position to where you can reach a true heart rate or ventilation challenge, while your legs are still hanging in there. Or the opposite. So the training protocol is based on that point of failure. The adaptation is in the same thing. So if you are failing because of your legs, then you might see a greater increase in capillarization in your legs, relative to somebody else who's failing in their cardiovascular system. They may see a greater change in something on that side of the equation. So it matters how you're failing, at all times. - What I love about this is that it's, it sounds like it's like a thermometer for where one is weak and needs work, but also provides a stimulus to improve the very thing that you need. - That's the trick, right? - That you need support in. So to just get real brass tacks about it, it would be once a week. - Okay, yeah. - 90 seconds near maximum heart rate. - I'll make it easier. - Could I do more? Could I, you know? - Oh yeah. - Could I do five or six of those 90 second bouts? - No question. You can do, as long as you touch that max heart rate, I'm good, right? Ideal world, probably four to eight. - In that single session. - Ideal. - Okay. - Right. If that takes you 20 seconds or 90 seconds, it's fine. If you want to do 30 on, 30 off. You want to do 20 on 40 off, 40 on 20 off, those numbers don't matter. - And is there an interference effect of this on the other sorts of training that we've talked about? - It actually tends to be complementary. The evidence available suggests that this high interval stuff is more likely to be complementary to hypertrophy training, probably because of lactate, and some other cool things, which are very beneficial molecules that people don't understand. They think it's bad, it's actually a hugely beneficial thing. It can be interference. It can provide an interference if calories are not accounted for, if rest is not accounted for, and other things. But in general, it's probably okay. I wouldn't add it to your equation if you don't need it, for maximizing hypertrophy. But for the person who

wants to just get well rounded physiology, yeah I wouldn't hesitate to do these, even in the same session or different sessions. - Terrific. And if that's done once a week, and the 150 to 180 minutes or so of zone two cardio is done, you know, in the rest of the week, person's doing their strength and hypertrophy training we would hope, what other sorts of endurance practices could one incorporate. You mentioned muscular endurance, like the ability, would like a wall sit or the ability to do a plank. Is that something, is that useful for anything? - Yes. - Be doing planks and wall sitting? - No no, it's extraordinarily useful. Let's hold on muscular endurance. I want to finish one more thing on this side. So if we're building this week of endurance, once a week hit that number, if you can do repeated bouts, we talked four to eight, that's fantastic. If you can't manage the mental energy every week, do it every other week. It's still very good, right? 'Cause I get it. Like I'm a working person too, and sometimes you're just like, I cannot. Those workouts feel incredible afterwards, but man, they are daunting. If you love this stuff, you could do it four times a week. If you hate it though, it's not realistic to think you're going to be able to knock this out. You're going to end up doing 70, 80%, which is not going to get you the benefit. So just don't do it. - You really have to hit that ceiling. - [Andy] You've got to get up there. Close. - Have someone chase, I always say, you know, when doing this kind of work, in my mind I'm thinking that I'm basically being chased by somebody with a syringe full of poison. - Yep. - And while there are other ways out of the situation, and for the benefit of what we're talking about, the one I'm referring to is to just run. - Yep. - Yeah. - My motivation is typically, if you just get this done, we're done in a couple of minutes. Just get it done. Like don't go here if you're not going to do it, but when you show up, check in, and it's over really quickly. - Breathing down regulation afterwards. - Hundred percent. You have to, right. It's a huge key. So if you absolutely can't do it, do it every other week. That's twice a month. Give me twice a month. Can be done on the road, can be done in 20 minutes. Like do a really good thorough warmup. Don't just jump into those, by the way, right away. It's not going to be as beneficial. Really nice, good sweat broke. A really good warmup. And then give me four minutes of hard work and we're done, right? Get out of there. If you want to use like a bath or hot thermal stress to kind of like aid in that warmup process, fine. Get in the sauna, get in a hot bath, get really hot, get up there, warm up, knock it out. Whole thing is 20 minutes, plus five minutes breathing. You're out of there. - I'm going to start doing this. - It's so better, you got a bike right there. - Yeah, I've got all, every room in this studio has a different piece of equipment, it seems. - So, I want that once a week, realistically every other week if I

have to. I want that physical activity piece, call it whatever you want, long duration thing. Ideally you'll do as much of that through your nose only. You're not going to be able to do the interval stuff at nose only. Don't even try. But if you can go that whole 30 minute time, or 20 or 40 minutes or whatever it's going to be, that's actually a good way to regulate intensity. So go as hard as you can, while still being able to breathe through your nose only. If you have to open up your mouth a little bit, fine, but try to stay there. What you'll see is very quickly, you'll be able to increase your work output while just breathing through your nose, which has a bunch of other beyond benefits. The other piece I want is this middle ground, which is, can you sustain hard work for eight to 12, maybe as little as four minutes? I'll give you four to 12 minutes. This doesn't have to be quite as high as the first one. You don't have to get to a heart end max, but can you get somewhere in the 80% range, and can you hold that for four minutes? Maybe gimme two minutes, two minutes of rest, and do that twice. Something like that. Ideal situation is what a runner would do is like what we'll call mile repeats, 'cause they're running four or five minute miles. Whatever time it takes them to finish, they're going to rest that. So it's a one-to-one work to rest ratio. So a five minute mile, rest five minutes, and go again. That's probably pretty unrealistic for a lot of folks. - Well the five minute part is unrealistic for most folks. For me it would be eight minutes, eight minutes. - Fine. - [Andrew] Probably something like that now. - Well in your particular case, just do the 800 meter. So do 800 meters. Do something that takes two to six minutes of work. It is a lower intensity than the max stuff, but is a much higher workload. That is probably going to give you, you might even argue the most cardiovascular benefit, because it is sustained work output. And that's very critical. The downside of kind of like that conversational pace. It's physical activity, it's movement, it's blood flow, it's lymphatic drainage, it's not very cardiovascularly challenging though. You're just not going to get an optimal health from just walking actively. - So two to six minutes of- - Hard work. - of hard work, with then an equivalent amount of rest in between, and then repeat how many times. - Once, if you have to. If it needs to be one rep, if it needs to be a six minute thing, and then down regulate breathe. Twice, if you can do that, six times, eight times, like whatever you can really do. And you can just take that as long of the training session as you want, or short. Exercise choice could be whatever you want. So again, you can do sled pushes, or it could be a kettlebell circuit, or any combination of things where you're just, you're working and you're not giving yourself a break. You have got to be able to hold on at a very high waste product production level, as well as a high demand for energy, and

then bring it down. - And breathing during this two to six minutes of hard output is mainly through the nose, or combination nose and mouth, or is that getting too technical? - Well, it's probably, like I like it, but you tell me if it's too technical. You're going to try to maintain nasal only as much as you can, but you're going to lose it at some point. You can go through their, Brian and Rob's gear system, and learn more, and then you can kind of see what gear to be in, if you have to go nose in mouth out, or something like that. But I don't really care too much, honestly, in that range. I'm getting most of my nasal only stuff at night, and training and everything. So if you have to open up the throttle there to get the work done, that's okay. Oh, then we'll actually go to your, answer your question, which was muscular endurance.

02:08:15 Muscular Endurance, Fast vs. Slow Twitch Muscle

Let's go back to that piece. Muscular endurance is incredibly important for general maintenance of joint health. In other words, you have got, form follows function, right? That's a very classic science-y physiology saying, meaning you've got a couple of different, there's a bunch, but to make it easy, two different types of muscle fibers, fast twitch and slow twitch. Fast twitch fibers tend to be, but they're not always, bigger. They contract with a higher velocity, that's why they are called fast twitch. But they tend to be more glycolytic and less fatigable. Slow twitch tend to be smaller, though not always. They are more packed with mitochondria, they are generally better at burning fat as fuel, but contract at lower velocity. Well we have these two types so that we can regulate function more. You have some muscle groups that were going, oh, sorry, let me go back up a quick second. Each individual muscle in a human body has a combination of some amount of fast and some amount of slow. That percentage of fast versus slow differs from muscle to muscle. So it also differs from person to person. Easy example is your calf muscle. There's three, but there's two primary muscles in your calf. One's called the soleus and one's the gastroc. The gastroc is the one where if you take your toe and point it towards your face, and then flex, that's the one that pops out on the medial side, the inside. The soleus is what we call an anti-gravity muscle. And it is generally about 80% to even 90% slow twitch. And that's because it's supposed to be contracted lightly, all time though. It's supposed to be on permanently. It's meant to keep, we call it anti-gravity, 'cause it's meant to keep you erect, up and moving. Your spinal erectors are supposed to do this, various muscles for postural are generally slow twitch muscles. So

they're supposed to be on at all times, not produce fast, not produce force, but don't get tired. The gastroc is the opposite. It's not activated very often, but when it's activated, it's meant for extreme propulsion. So this gives us the ability to reach up and scratch our eyeball, and also punch somebody, right? We have to be able to regulate force output, which is going back to Henneman right? Controlling what we use, what we don't use, while also not wasting energy, which is the downside of activating a big threshold motor neuron is it requires a ton of energy. So a more efficient mode of energy, but the total amount is really, really high. So muscular endurance is going to help those slow twitch muscle fibers and slow twitch predominant muscles maintain their working job. So if you lose your muscular endurance ability in your spinal erectors or your calf, you're going to start slumping into bad positions. You're going to be getting, putting joints in a movement pattern that they're not going to be the most happy with. So it's more than about then being able to just maintain a two minute wall squat. It's about maintaining joint integrity, and allowing that musculature to not fatigue when you ask it to do heavy and fast. So what I mean by that is, you've got a whole combination of muscles in your shoulder, and we will generally call these like the rotator cuff muscles. Well, let's imagine those slow twitch postural muscles get fatigued, and they start to lose contractile tension. And then you go to do something heavy or fast, or in an emergency situation. Those are already pretty fatigued. You're going to rely more upon the fast twitch muscle fibers, which are there less for postural integrity. You're likely to get out of position. And this is a whole recipe of like, God, why is my shoulder just hurting? God, my back. That's very often a case of the slow twitch fibers and the slow twitch muscle groups losing muscular endurance. So you need to build that back up, so that they can control and hold the joint in the position, so the fast twitch fibers can then contract with force. - I'm hoping that what I'm going to say next meets what you said accurately. My experience is that getting injured lifting weights, or even doing house work or yard work, almost always happens when I'm not paying attention, fatigued, that's kind of obvious, but also getting in position to initiate a movement. Setting down a weight or lifting weights off the rack, or picking up dumbbells. That's almost always when I seem to activate this lower back thing that happens every six or eight months. And what you're saying, if I understand correctly, is that this muscular endurance from wall sits or planks, or things of that sort, maybe you could give us a few other examples of these, can help us because they actually prepare the system to do what we normally think of as the more intense work. So it's really the, it sounds like it's really the architecture of the body, includes nerves and muscles and

everything else of course, that lets the limbs and other kind of action end of the body do its best work. Is that a good way- - Yeah, let it express its own power and force. Yep. We've actually landed on one of my final laws of strength and conditioning, which is, similar to what I said earlier, right? So I said, exercises do not determine adaptations. Application determines adaptation. This one sounds similar, but it's quite different. There are no good or bad exercises. There's only good or bad application. Here's a great example of that, right? So you do not get hurt dead-lifting because deadlifts are dangerous. You only get hurt dead-lifting because you either got in a bad position. You got in a bad position because you either started in a bad position, which is one of the things you just said, or you ended up in a bad position. You did too much volume. You did too much intensity. Or you did too much complexity. Those last three things all hurt you because they result in the first one, which is out of position. Or another way to think about this is if it's not a visible change in position, is stress got put into a part of the system that should not absorb that much stress. So you did too much of it. You did it too heavy. You got fatigued. And so you broke position. You got too heavy, so you broke position. You made the exercise too complex, you put too many moving parts in it, you put too many joints in it, and you got out of position. You did that too many times, over time. Now we've led to either an acute injury, bam, back pops and you fall on the floor. Or just like, man, this thing is hurting over time. All these are result of the same thing. So you cannot ever blame the exercise for causing the problem. It's always either the user or the coach. You programmed way too much here, and I can't handle that position. Or you yourself went into it too much. So if you're getting these little tweaks and problems going on, you've made an error in one of those things. So simply back off. Reduce the complexity, right? Give yourself more stability, less moving parts. Do less volume. Do less intensity. In fact, if you look at the people from the physical therapy world, in terms of the pain literature, it's very clear that just stopping a movement is very rarely going to work. What you want to do is back off all the way down to just below that threshold of that's what aggravates it, and you want to train right there. That's going to allow you to do two things. Number one, tissue tolerance. And then number two, desensitization. A lot of pain stuff, and you can probably speak a lot about this, is, especially with things like low back pain, is there's not necessarily often much damage there. It's a lot of hypersensitization of just pain signal, pain signal. Omitting the movement entirely does not get that signal to go away. You need to train just below that signal and desensitize it. So you want to make sure that the muscular endurance allows you, you're just putting

volume right below where you start to get a tweak. And it is beautifully effective for that. - Yeah, I've experienced this right side lower back pain for years, sometimes shooting down the hip. The two things that really helped were doing anterior tib work. So hats off to Knees Over Toes Guy, Ben Patrick, who has created a lot of popularity around tib work. But- - Turns out joints, full range of motion, you're in a better spot. - Yeah, something about stabilizing the stuff from the knee down helped my back. And then also some neck work. And friends of mine are always teasing me that my gym is filled with the most bizarre equipment. It doesn't look like any other gym. A lot of it's just designed to keep me healthy and still training, but. I love this idea of getting right at the, below the threshold of pain activation, and not simply going into complete non-action, or just taking complete rest,

02:16:35 Hydration & the Galpin Equation, Sodium, Fasting

'cause that actually can be detrimental. I'd love to talk about a few items that support training of all kinds, and where there's a lot of confusion and indeed misconception and mystery. And just get your take on these. And I just want to acknowledge at the outset that for some of these, there's a lot of science, for some of them there's less science, but there certainly is a lot of experience in your camp. And those categories are cold, heat and hydration. - Ah! - Because obviously whether or not you're a runner, whether or not you're strength training, if you're a human being, you need to hydrate. But in terms of work output and physical work output, maybe even cognitive work output, maybe tackle hydration first, There is what I call, and what I think has now come to be known as the Galpin Equation, which you really do deserve credit for. Because I think that people realize that there are a range of solutions out there, but there is a really, a desperate need for straightforward solutions that work for 75% of people 75% of the time. So hydration is key. Maybe you could underscore just how key it is for us. And then what is the Galpin Equation, as I call it, and I think others are now referring to it. - Yeah, okay. Benefits of hydration slash consequences of mis-hydration. So whether that's dehydration or overload. Physiology has hormetic curves. Right, now typically we think about this in terms of toxicology. So what this means is at some point giving you a dose of something, testosterone's a very easy example. If you're clinically deficient or low in testosterone, and I give you a little bit, and it brings you back into a normal range, you generally see an improvement in health and functionality. Taking you though from

normal to super high, doesn't always necessarily provide additional benefit. In fact, if you continue to go, it's going to provide detriment, right? So everything has this curve. And then some things are hormetic stressors, which means like a small, short, fast insult is actually beneficial because then you come back bigger, faster, stronger. That's how adaptation works. Basic hormesis, okay. Hydration's the same way. So at the end of the curve here, if you are under-hydrated, we all know you could die, right? You have to have things, in fact water is the only thing that is ubiquitous across biologies, in terms of every living thing has to have it. There's no other vitamin, mineral, nutrient that is required among all living things, with the exception of water. So that should give you a pretty good indication of it's [speaking in foreign language], right? Like you got to have this thing. Down here at the bottom, if you're dehydrated and I give you more, it's beneficial effects. However, if you are up the top already and I continue to give you more water past that, now we run into actual problems, and we can get what's called hyponatremia, which is more common than people realize. Nitremia being, actually not referring to the water, but the sodium concentration being too low. And you've probably talked about that at length of why that's an issue. If sodium potassium balances inside, outside of cell, come off, heart stops, right? Muscle contraction ends, and all these things. So you don't want to be over or under-hydrated. So understanding this rough equation I sort of loosely calculated one day, is helpful for that. I think the most context is talking about how much water to drink throughout the day, and then how much water to drink during exercise. So the very easy answer is half your body weight in ounces per day, is a very loose guideline for total amount of fluid consumption. So if you weigh 200 pounds, aim for a hundred ounces of water. It's like a very easy number. If you hit that, you're probably, I'd say, 90% of you are good. 90% of the time alone. If you then go to exercise, you need to then account for that fluid loss with exercise. And in general, you want to consume 125% to 150% of the amount of weight you lost in fluid. In other words, if you worked out and you were 200 pounds naked, and you went and did your workout, and then you dried off, and you weighed yourself again, and now you're 198 pounds, you lost two pounds of water. That's 32 ounces. You want to drink back about 125% of that. So instead of drinking 32 ounces, I want you to drink 40, 42, 45, like something like this. 'Cause one of the reasons why is, unless you're drinking something that is isotonic, meaning the same exact concentration in your blood, and that you're in your fluid, you're just going to go closer to that hyponatremia. You're going to get a bunch of baroreflextor responses, and you're going to actually think you have too much fluid and you're going

to urinate it out. - What if I'm not weighing myself before and after workouts? And is there a shorthand version of this that, after training for an hour, I should drink at least X number of ounces. - Yeah that- - Assuming it's at kind of, I'm not sweating super heavily. - Yeah. In that particular case, you could probably go something like, if everyone in the world did, I don't know, 12 to 20 ounces, that's probably like pretty decent. - And they're probably doing that, right? - Yeah. - Yeah. And what about electrolytes, consuming salt, potassium, and magnesium? - But that thing only works though, if you're coming in at optimal hydration. And this is the problem, this is why you have to, you have to flag this starting with a good total daily amount of water. Because if you're coming in and you're like oh I drank two or three glasses of water a day, then you might need to drink 50 or 60 ounces post-workout, 'cause you are way behind. So that like oh 12 ounces or so works, if you're already generally very well hydrated. - And if people are drinking four to six glasses of water a day, but they're also drinking a lot of caffeine in any form, then they're going to be excreting more water, in most cases, right? - Well- - because caffeine's a diuretic. - Okay. It kind of is, but it kind of isn't either. It's not the diuretic that we used to think about it as. It is still fluid consumption. So it's only a diuretic if it causes you to excrete more fluid than actually was being intake. So if caffeine intake is in a normal range, I don't have to worry about the diuretic effects. If someone is drinking 12 cups of coffee a day, we're going to, or they're taking caffeine pills or something, now the excretion is going to out-kick the coverage. So now we're going to have problems, right? 'Cause there's no fluid consumption with the caffeine pill. So in general, things like tea consumption, like I'm not super worried about those things. You can count those towards your total fluid intake if you want. So if you're like, I drink 60 ounces of water plus 20 ounces of coffee, and then this, like you're going to add that all up and you're going to be totally okay. So natural, you also have problems with synthetic forms of caffeine versus natural forms of caffeine. Natural forms are pretty okay. They'll be just fine. - So coffee, tea, et cetera. - Yeah. All that stuff. - Pill form is where it gets tricky. - Always. Like always, right. So general, just eat real food and things. You're going to be just fine. The last piece to consider is your diet quality matters. Because the fluid content in your food can vary wildly. So something like a bagel might be five to 10% water, or something like a watermelon is 98%, 95%, something in a huge range. Even meat is very high percentage of fluid intake. Like it's really high. Even after you cook it, there's still a lot of fluid in there. So if you're eating a wholefood, mostly wholefood-based diet, your endogenous hydration is actually pretty high already just from your fluid. If you're eating

a very highly processed, dehydrated, over-salted diet, you're way low on hydration, just in your food. So you have to factor all these things in, in fact, one of the things that happens to us constantly with folks that go from a like highly processed, low quality diet, to a high quality one, is they're just peeing nonstop. Like what the hell's going on. I'm like, well you actually have brought in 60 additional ounces of water in your diet, relative to what you used to have. And you've gone from 10 grams of sodium there to four, to two, sometimes one. Sometimes it gets very low 'cause you're not like salt, are you salting your food? No. Okay. Well we don't have sodium intake then. Like we're way down. So everything that we're considering is based on that. So let's assume someone's eating a pretty well balanced diet. They're drinking 16 ounces of water and maybe some caffeine in coffee and tea, things like that. We don't exactly know the optimal amount of sodium one should intake. It is very clear, high sodium concentrations are still associated with a lot of negative health outcomes, especially in combination with poor physical activity, in combination with low food quality and other comorbidities. That's a very bad thing. You need to be very careful about those things. If everything else is okay, we're okay playing with a little bit of higher salt. In fact, you're probably going to feel better. You're going to feel generally pretty good. You just, it needs to be very clear. If you are overweight, highly stressed, and you don't have a lot of these things ticked off and you have known comorbidities, you really need to pay attention to salt intake. It can be very nasty. So that being said, what we're generally going to look at in folks is, are you at least, can we categorize you as a low sodium or high sodium sweater? If so, there's a whole list of electrolytes you can look, that are going to have something like 200 to 400 milligrams per serving. And there's a whole list of these things. If you're a low sodium sweater, I'm probably going to send you after one of those. If you're a high sodium sweater, there's a lot of electrolytes supplements that are closer to six or 800, even a whole gram per single serving size. So you want to play with that. A very- - How do you know if you're a low sodium or high sodium sweater? We actually have an episode on salt we put out that, or is coming out soon if it hasn't come out already, which is when you look at the hazard ratios for salt intake, basically your probability of really bad things happen to you goes way up as you get towards a lot of sodium intake, 10, 12 grams per day. - Totally. - And this is translated to teaspoons of salt, et cetera. But also very low sodium intake is a problem. - No question about it. - So it's a, it's not a perfect U shape. It's kind of a J shaped curve, or a kind of hockey stick shape more or less. But how would I know if I'm a low sodium or a high sodium sweater? - Yeah, so you can get-

- Would I just kind of lick my sweat or have someone else do it? - Well you can. Find a super friend who'll lick your sweat for you. Same how- - No willing volunteers that I'm aware of, but would I be able to tell? - Yep. You can get sweat testing done. Actually you have a number of options. The kind of, the original one that most of us used in the background for many years is called Levelen. They'll send you out a little patch, you can wear that, send it in the lab, and they'll measure it directly in the lab and send it back. It's 150 bucks or- - Did they bin you into low, medium, and high sodium? - They're going to do that, but they're going to give you very, they're going to tell you exactly the milligrams. And they're going to actually tell you like what products and stuff that are exactly matched. - Do you do this with professional athletes? - [Andy] We have many times. Yeah. - Interesting. - You can do a more consumer grade version. Gatorade has a patch. For 25 bucks you can get two of them. You can put that patch on your left forearm and download the Gatorade app, and you can do a workout, measure it right there and click it over, and they'll tell you exactly, not only high or low, but again, they'll tell you the milligrams of sodium that are in your sweat, and then you can figure out, again, kind of high, medium, or low. - Interesting. I do much better on a slightly higher sodium intake. - [Andy] Most do. - But in my carbohydrate, I do eat carbohydrates, I'm one of those that it is pretty moderate, but I try and eat clean foods. So I'd notice, and I tend to be slightly low blood pressure. So again, to reiterate the warning there that if somebody is pre-hypertension or has hypertension or obese, you really do need to be careful with your sodium intake. But many people seem to find that they feel better when they increase their sodium intake, and they're still in that healthy portion of the hazard ratio. - Most of the athletes, I would say in general, are going to go higher in salt. When they come, we're going to run their stuff and we're going to add salt. Almost always. Very few times have I gone ow, we need to cut this back. One of the exceptions are the ones that come in that eat like 14-year-olds. And I'm like, okay, you're at 15 milligrams, or 15 grams a day, 'cause you're eating nothing but. - Garbage. - So we're like, we're going to come down, you're going to feel way better. All this bloating and everything else that's going to happen. Go down. You can do that, there are actually more, there are biosensors that are coming out that are not available yet, but they're coming very soon in this space, that are going to give you real-time metrics on salt. So you can pay attention to those. I haven't seen one and used one personally, so I don't want to espouse about how good or bad it is, but I know that those are coming from a handful of companies. An easy way to do is just look at, wear a hat, or wear some sort of headband or something and do

your workout. Take it off. If you see a just huge white band, or if it's completely clear, then that's going to tell you. Big white band, you're probably a high salt sweater. Completely clear, very little coming out. - That's great, and I can see the posts on Instagram now, people showing their salt band from sweating. - Yeah. - And obviously salt is so essential for so many physiological functions. You don't want too high or too low, but if you're losing more, it makes sense you would need to take in more. - Yep. - So half of my body weight in ounces, as a just foundation of a fluid intake. Coffee and tea could be included in that, but that should probably be mostly water or things similar to it. And then during exercise the, how do I want to think about this again? Let's say I'm a high salt output, then I'd want to drink maybe 40 ounces water with or more. - Yeah, okay. I'll do this easier. Let's talk about pre and mid and post, right? So what to drink pre, if you come in having hit these rules, you're okay. And pre workout can be as little as like five or six ounces. Basically a couple sips of water. Fine. If you come in poorly hydrated, then you maybe need to go more like 12, but here's the deal. If you start off a session in a bad spot, you're not going to catch back up. Like you just, you're in trouble. Let's say you come and you follow direction. 500 milligrams salt before, 500 milligrams after. A very easy rule. Pick whatever source you want, that's a couple of sprinkles of table salt. If you want Himalayan, that's fine, you don't have to. Himalayan's actually a fairly low sodium salt, so it's not the best for this purposes. If you're a higher salt sweater, a little bit more. If you want to go choose an electrolyte, of which there are infinite, you can look on the packet and it'll tell you, 250 milligrams per serving, or 400, or 600, or whatever happens, but around 500, pre 500, post is a very general rule. And then during is, thanks to you, my famous Galpin Equation now, that is all over the world. All I did is I took the literature and I said, okay, in general, the research shows pretty clearly two milligrams per kilogram body weight over 15 minutes seems to put you in a pretty good spot. Most people don't think about kilograms or milliliters. So can I just run that over, and then turns out it's about your body weight divided by 30 in ounces. Like that's all you have- - Body weight in pounds divided by 30. - Yeah, exactly, right. So you weigh 200 pounds, divided by 30, and that's the number of ounces. You're going to want to go every 15 or 20 minutes or so. - So I'm getting that amount every 15 to 20 minutes throughout the training. And now in the weight room, that's pretty easy to do. 'Cause there are rest intervals. But people will need to do this while running or cycling, and that can cause a little bit of gastric distress, if you're not used to it, is that right? You can learn to run with some water in your belly. - A hundred percent. The gut is very trainable in a lot of

directions, but in terms of fluid, as well as carbohydrate, which is another thing that is going to get people, but that's yeah, very trainable. It'll be uncomfortable initially, but you'll quickly get into it. The better solution for those folks, just come in hydrated. And you might not even need any water. You could probably perform just fine. So the ones that don't have as much of an opportunity, you really have to emphasize walking in. We have this problem with like professional golfers. They have plenty of time to drink water, but they're so focused on the shot and there's a lot of variables coming up, once they hit their shot and they're moving on to the next one, they're thinking about, I mean, they're going over a scorecard of 185 yards away. Can I go 184 1/2 yards, can I go 186 yard, what's the slope of that, what's the wind up here, what's the wind up there? Like they're just thinking, and they just forget, even though they have 4 1/2 hours, so we have to make sure that they immediately get off the course. We go right into recovery, as hard as we possibly can. They wake up the next morning, they're in a good spot, we crush recovery. And now it's like, hey, if you can remember to drink this, great. If not, we're still fine. If it's not a big deal, and you have time like in a lifter, because I deal with that problem with fighters too. Like we can only drink so much in the middle of a fight. A couple sips over there. But we can't go mix and. Two mills. It's like, can you get a couple sips in, yeah, oh shit, forgot like, it's not going to happen. So we have to take more of an emphasis before and after. So start your recovery process immediately, and then come in the next day, that's your window. And then whatever you can get in during the workout, that's fine too. If you're a higher salt sweater, instead of going 500, 500, maybe go 750, 750. If you have a longer about of exercise, especially if it's hot or humid, then you might want to consider some salt in the workout as well. And 300 milligrams during the workout, totally fine. It's enough. If it is a really long workout, and it's really hot, and you're going to lose pounds during it, you need a specific strategy. If you're going to lose less than a pound, you don't need to worry about it. It's not going to be enough of a detriment for you to really care. So that's kind of a rough rule. Now, if you're 200 plus pounds, maybe that number moves from one pound to two pounds. But really the number we're looking at is 1% of your body weight. If you're losing more than 1% of your body weight, we need to start caring. If it's less than 1%, it's not going to really pay that much of a difference. - Okay, so for myself, because I don't get super technical, I don't wear any devices besides a wristwatch. - It's a nice watch too. - Thanks. Yeah I do, very attached to this watch, or it's attached to me, I suppose. My body weight in pounds divided by two, that's what I'm going to try and get across the entire day as a kind of

baseline. And then my body weight- - Oh yeah. - in pounds divided by 30 during the workout, every 15 or 20 minutes, that I'm going to try and consume that amount. And then I definitely do better when I increase the amount of salt that I'm taking in anywhere from 500 to, 500 milligrams to a gram of salt, several times a day, actually. But I'm not eating that often, which leads me to my other question, which is, I prefer to train fasted or semi-fasted, meaning first thing in the morning or within an hour or two of waking. Obviously I've been fasting while I'm asleep. Or having not eaten anything for three or four hours before. I just feel lighter and like more energetic. If that works for me, is that okay, or should I try, is it better to eat something before one trains? - Personal preference. Easy, easy answer there. - Great. - It depends on of course how hard you trained, what the training was like, what sport you're involved with, how many total calories, et cetera, but in general, personal preference for the average person. - Yeah, that probably handles 90% of the questions about that.

02:35:57 Cold Exposure & Training

Cold. Cold showers, ice baths, and cold immersion up to the neck. I always preface this by saying there are not a lot of studies. There are some, but not a lot of controlled studies looking at cold showers, 'cause it's harder to control the variables of where people stand. So I would say if you have access to a cold immersion of some sort, ice bath or cold immersion, great, but if you don't, cold showers would be the next best thing. The lore goes that if you do an ice bath or cold water immersion after strength or hypertrophy training, that you are short circuiting some of that. The lore also goes that cold showers might be okay. And my interpretation of those data and that discussion is that all that is probably true, but I have a hard time imagining that the effects are so robust that it can completely prevent strength gains and hypertrophy, such that my stance for myself is try and do the cold exposure training away from the strength and hypertrophy training. But if you can't do it any other time, right afterward probably isn't going to throw my whole system out of whack and prevent the improvements. Am I deluding myself? - A couple of caveats here. Number one, obviously I have a personal vested interest in cold. I've been around this stuff for a long time, being involved and being an advisor for XPT, and being in this space a long time, I'm a big believer in cold. Especially cold water. - Deliberate cold exposure. - Hundred percent, right? So that being said, I do think getting into an ice bath immediately after a hypertrophy session is

getting pretty close to you just shouldn't have done the session. It is detrimental. - [Andrew] Good to know. - I wouldn't do it, I guess is the most blunt way to put it. If you're like hey, like I'm not super concerned with growing muscle, and I want these other things that come with cold water immersion, fine. It's not zero, it's not taking you backwards. How much does it cut you down? I don't know. We don't know, like that'd be a difficult number to come up with. Is it 1% reduction? No, it's more than that. Is it a hundred? Not even close. I don't know where it lands though. It's enough though for me to go in general, best practices, don't get in the ice immediately after a workout. - How long should I wait? - Well, in theory, the best answer we could give you would be four hours, because of what we talked about earlier today of going okay. Immediately, you've got the signaling cascade that takes seconds. You've got gene expression that's happening in this rough four hour window. After the genes have gone off and now you're just going through the protein synthesis process, the signal's already there and it's gone back down to baseline. So then reintroducing, or introducing cold here is not going to disrupt that signal. That's a very non-scientifically founded because we don't know, at this point at all. What is very clear though is if you get off your workout, go right into the ice, it's probably 10% attenuation of growth. I don't know, maybe more, depends on the person. Some people, if you look at the individual data, it's pretty bad. It's enough to where it's like that's a really big deal. The benefits of the ice, I don't think now outweigh the benefits of the hypertrophy training. - What about cold showers? - I don't think cold showers are going to do much. if you've been in both, you know that this is like, we're not playing the same game here. - Right, an ice bath or true cold water immersion up to the neck with limbs in, for one to five minutes, is a completely different stimulus than in the cold shower. - Especially also compared to a similar like cryo, right? It is not even the same thing here. So in general, I would say, don't do those cold shower, I don't really care. Can you work it out so that you don't do them the same time? That would be my hope, right? I would actually prefer you do the cold before. If you really had to do it. - Certainly will wake you up. - Oh yeah. - Get that adrenaline burst. - No we've played with that actually years ago, doing that. There's actually some fun stuff you can do with the endurance piece, with cold stuff. But it's totally not feasible for most people, 'cause you're getting water everywhere, then you're going to jump on your bike and just get shit, and it's just a giant mess. It's fun, but yeah, I would say walk away from it if you can. That's actually, that's where I stand based on the data. Based on my intuition and experience, I don't think it's a good thing to do. Now having said that, that's mostly

concerned with maximizing hypertrophy. Strength, it's not as clear. There are some data to show what actual block strength adaptations, but because of what we talked about earlier, the mechanisms and the drivers are different. And so I don't think it's as big a concern for strength development, though I would still generally say, if you can get away with staying out of the ice immediately after the workout, and you can at least wait a few hours, that's the better approach. Less concerned with strength, more concerned with hypertrophy, in terms of interference effect. If you can do it on off days, or before, any other time, that's the place to land. - That's generally when I try to do it. - Yeah. - I was just kind of throwing out an extreme case, 'cause I get asked that question a lot. What about the use of ice bath or cold water immersion, or cold shower after endurance training? - Okay, so a couple of interesting things here. You mentioned we don't have a tremendous amount of data on cold water immersion overall. So a lot of this is moving. There have been some papers to show that cold water immersion can actually enhance mitochondrial biogenesis. And actually, even for endurance stuff it's been shown to cause improvement in endurance adaptations, relative to not. It's not enough for me to be truly confident in that statement yet. I would like to see that repeated, not that I have a problem with the paper, the methodology that they use in that particular study, but it's just, like this is a weird thing. So I want to see this repeated more often. So I have less concern with doing it immediately post-endurance, 'cause you could even argue that there may be some benefit. I don't think you need to go out of your way to try to make sure you get into ice immediately afterwards and thinking you're going to get some massive adaptation. We use ice a decent amount, when I can get athletes to do it. But this context is different. Number one, when we're in camp and we've got a world title fight coming up, or something else, we've just pitched in a major league baseball game, I am not concerned about hypertrophy. I am not even concerned with strength development. I am now pushing towards recovery. There's a paradigm that I think is important with all of these things to understand, which is, are you pushing for optimization or adaptation? When you're pushing for adaptation, you don't want to block the signal for adaptation. This means less recovery. You're not going to feel as good. And you probably should be hedging towards stress. When you're pushing for optimization, it's the opposite. So if I'm in season and I had a pitcher just throw 125 pitches, I'm not trying to cause adaptation. I'm trying to recover as quickly as possible because four days from now we got to do this again. And I got to do this across 162 games. You're going to play five days in a PGA golf tournament, and you're going to

have to do it again every week for a bunch of weeks in a row. I need recovery as fast as I possibly can. So if I'm blunting adaptation fine, I'm not actually trying to do something, I'm trying to optimize. If you spend all of your time in one of those two areas, you're going to have problems. So you need to be judicious about thinking is this a point in my life, or a training cycle, that I want to cause adaptations? Or am I trying to optimize? You spend too much time in one of the other ones, again, you're going to have problems.

02:43:15 Heat Exposure & Training

So that's in generally how I will treat the ice for all those adaptations. - What about heat? - [Andy] Yeah. - When, and I'll frame this question differently because I'm sure there are a number of ways in which heat can short circuit all sorts of things. I mean, heat in excess can kill you. It can shut down fertility. It can, in excess, right? It can do all sorts of things, but it can also increase growth hormone, increase vasodilation, improve one's ability to sweat, which can be very beneficial in a number of contexts. - Yep. - For the typical, for 75% of people, 75% of the time, when do you think heat is most useful? And here I'm referring to dry sauna or wet sauna. I'm not specifically talking about infrared sauna because the data there are a little unclear to me. And I don't even know that, my sense with infrared saunas is they don't go hot enough for my particular taste. - You and I have a similar taste there. - Okay, yeah. - If we're not crushing 200 past I'm not interested. - Right, and my sense about infrared sauna is that, maybe I haven't seen the data, is that, but that a lot of people like it 'cause they like the way they look in the infrared sauna. It feels cool, it feels like you're doing something unusual. Now infrared lights are beneficial for other reasons, actually for mitochondrial health and the retinas, the good data, but infrared sauna to me it never goes hot enough. So I'm talking about 200 or hotter, maybe 180 to 220. Obviously do what's safe folks, and heed all the warnings about pregnant people not going in saunas, et cetera. - I assume you're lumping in hot water immersion- - Hot water immersion, so hot baths, hot sauna. When do you think most people could leverage sauna or hot baths to benefit their training and fitness and health? - Yeah, okay, I have a handful of things to say about this topic. One of 'em is, you never have a hard time convincing people to get hot. Everyone feels good. Like yeah, get in a hot bath, like, can you take more hot showers? Sure. Like no problem there, right. There are a handful of studies that have looked at this immediately post, and it seems to even augment hypertrophy. - So after hypertrophy training, getting in the

sauna for 20 minutes. - Yeah, whatever, whatever it needs to be. We don't have a good titration. What's the number minutes wise. We don't have a temperature titration. - Hot shower would be a second, would be a weak second best. - I would say it's a very weak- - [Andrew] To the hot bath. - I think a hot bath is probably a lot closer to what you're looking for. It actually kind of goes back to our initial conversations. Theoretically, you're just going to aiding blood flow. So you're going to put more nutrients in, more waste product out, metabolic stress, all that stuff is going through. So that's the thought anyways, we're far from knowing, - Makes sense. - Plausible, right. Absolutely plausible. Something people will do. Feels good. Let's say, with cold and hot, I want to caution you against a couple of things. This is true across all physiology, but you need to be really careful about moving percentages from molecular to outcome. Very careful. So for example, it's easy to see a paper that says, okay, we put you in a hot bath or something, and we saw a growth hormone increase 300%. That is not going to result in 300% increase in muscle size, right? In fact, 300% might result in absolutely no change in a physical size, right? And the reason I'm saying this is because there's a lot of people in this space that will misapply the mechanisms. And they'll grossly overestimate what these things can do and what they do do, because they'll find something like that. I mean you know this, you've done enough cellular work too. In the lab, if I see mTOR doubled, I think shit, it didn't work. I need to see a 10 X increase before I know it's even physiologically relevant. So reading that paper, reading someone's social media post, you're like wow, it increased mTOR 38%. I'm like, well, that didn't work. And you're like, wow, that's huge. I'm like, that's not 38% increase in muscle size. So that's a very important point I want to make, because I'm going to talk about the benefits here in a second. But I don't want people to be fooled into thinking that this is some crazy miracle. The same thing with the sauna. In terms of general health outcomes, it is clearly a beneficial thing. This is a really good idea to get hot a lot. It is not a substitute for exercise though. It's a very important distinction. If the options are nothing or sauna, get in the sauna. Really, really good idea. If the exchange is though, I don't need to work out because I did the sauna, bad. This is not a winning solution. - You and I know some maniacs that actually work out in the sauna. - Oh, we do. Yeah, kind of not far away. - I don't necessarily recommend that. That actually would probably kill a large number of people. But it can be worked- - Yeah, if they die, they die. - It can be worked up to. - [Andy] Yeah. - Certainly. - Yeah. So I want, like every time I talk about that I flag that, because it's just too easy to hear that and go, oh, well I think Dr. Huberman said, if I just

get in the sauna, I don't have to work out. Like no, no, those words have never come out of his mouth. - He definitely didn't say that. And I'm definitely not working out in the sauna. If I'm in the sauna, I'm either sitting or I'm lying down, and I'm trying to make it through. I tend to do three 20 minute bouts, across the entire week. So I aim for 60 minutes per week of heat exposure. - I would be lying, - Which is not a ton. - if I said I've never worked out in the sauna. - Oh, so you're one of those. Yeah, people will do air squats, they'll bring the Airdyne bike in there. I look at the sauna as kind of a time to get lazy and sweat. - Totally fine. Going back to your original question. So potential the plausible aid, we need to see more research on that to really get a, do I need to put this in practice. I think if you try it, very little harm. I struggle to see a downside. If you make sure your hydration's on point, right, 'cause now you got to factor in the fact you just kicked out two or three pounds. If you at 200 plus pounds, I assume, or roughly, if you're in the sauna for 20 minutes, I would imagine you can do two or three pounds. - Yeah, I usually, I hover somewhere around like 225. And I drink a 32 ounce, it's water with a electrolyte solution that's pretty high salt afterwards. And sometimes during. And sometimes after that, if I do it late in the evening, I'll go to sleep and I'll wake up in the middle of the night just feeling so parched. It's amazing how much water one loses in the sauna. - Like a normal sweat rate for someone 225, especially in 20 minutes in a sauna, I would absolutely expect you to do three pounds easy, without like- - So I should be drinking more? - Probably. - Even more water. - Yeah, you're probably half the water that you need to get. - And you mentioned the possible benefits of doing it after strength hypertrophy training, which makes sense for plausible mechanistic reasons, no official data there yet. What about after endurance training? Assuming somebody hydrates well enough and they're not overheated from their endurance work. - Yeah. - [Andrew] Could also be of benefit. - Yeah. - Wow, so more and more what I'm thinking the framework here is in an ideal world, one would train and then do sauna, or heat exposure of some kind. Endurance training or strength hypertrophy training, and then do sauna, and then do cold exposure on off days, or at least four hours away from any kind of training, or if you had to do it close to training, doing it before training. - Yeah, I love cold in the morning. We've actually run this experiment on professional athletes, where we do enough tracking with things like HRV, which is a global metric of like overall fatigue, okay. And you've probably talked about that before but, problems with it, but roughly idea of overall fatigue. HRV in general, higher the score the better, right? So a low HRV is fatigue, right? Well, if you wake up and take your HRV in the morning, and then you

get into ice, what's going to happen is you're going to see that number plummet. The second you get out, that's going to fall off the Earth, which means roughly you've moved into a sympathetic place. Surprising, you get in 30 degree water, you're going to go very sympathetic very quickly. However, if you continue to watch your HRV for 30, 60, 90, and up to two to three hours post, you will generally see an improved HRV score relative to where you started. So it's back to this hormetic stressor, right? A really cold, shocking exposure will be a net result of you being more relaxed throughout the day. In general. And we've seen that now like very consistently across years, with athletes. So I think it's a great way to start your day. You won't need nearly as much coffee after spending three minutes in 30 degree water. - 30 degrees is pretty darn cold. I was in the ocean this morning for about three minutes. It felt, I didn't bring a thermometer, but it felt like somewhere in the low 50s. - But 50 and moving is really cold. - Yeah. - Water's moving. - Yeah. - Right. That's really cold - That's right. The thermal layer that surrounds you when you sit still in cold water immersion, I'm encouraging people now, if they really, I was, joked that people like to look real stoic and tough when they're in there. Like they're just grinding through it with no pain at all. But the stillness is actually reducing the stimulus. If they sift around a little bit, you break up that thermal layer. That's where the real action is. - We've joked about this for years. Like do 50 degrees with a whirlpool jet on, now I'm impressed. 'Cause that is hard. You sit in 35 degree for three minutes, I guess. But with XPT I've seen, I can't even tell you how many hundreds of people from all walks of life, on all age, that we've been able to get in 30-something degree water for three minutes. 50 degrees with a whirlpool going, that number gets very small. - Yeah, and if you don't have access to a whirlpool, this should be reassuring to you, you can, some people say oh, you know, I don't have access to ice, and ice can actually get pretty expensive, if you're doing a $50 ice bath - Yeah, it's- - every day. So you can fill your bathtub with cool to cold water, get in, but just make sure that you keep sifting your limbs and it's chilly. - Yeah. - And the studies on the very well, now well established increases in dopamine and epinephrine that occur in cold water exposure, were actually done at an hour in 60 degrees Fahrenheit. - Yeah. - And so it, you don't necessarily need it ice cold or an ice bath. But immersion is really better than the cold shower. The cold shower is kind of a, it's the, it's kind of the espresso shot version. - Yep, no it's sort of funny, 'cause if you look at most of those initial studies and you think, man, how do they get people to sign up to spend 45 minutes in 55 degree water. 55 degrees is cold. Even if it's not moving and then they're going to not spend five minutes in 'em, they're going to go an

hour. And if you've ever done ice baths at that temperature, you know like all right after a few minutes, it's not that bad. But man, that's a protocol. - Yeah, it's kind of a cold endurance protocol. 'Cause it's one thing to get in for one minute to three minutes, and you know you're getting out. You could sing a song, you could do anything to distract yourself. But 45 minutes to an hour is intense. Maybe they, I don't know. I don't think they paid the subjects. But anyway, that study was done - Yeah, you think- - in Europe,

02:53:47 Recovery

I forget where it was done. But anyway, they were hardy subjects. I want to talk a bit about over-training and gauging recovery. So there are a couple methods that I've heard about, and that I use, based on some data that I've seen, but mainly discussions with really informed people like yourself, Brian McKenzie, Kelly Starrett and others. The two that I'm aware of for gauging recovery of the nervous system and kind of systemic recovery, are grip strength, especially grip strength on waking in the morning. And the so-called carbon dioxide tolerance test. The ability to do a long controlled exhale after a few rhythmic deep breaths. Which I'm assuming taps into both one's ability to mechanically control the diaphragm, but also how well one is regulating carbon dioxide. First question is, is this stuff fiction, fact, or a combination of kind of anecdata, as I call it. Are there any peer-reviewed published data? Is your lab working on these things? And am I deluding myself, using these tools, or are they useful? - It's not fiction at all. There are, with like CO2 tolerance, there's less published data. We've run a study in our lab, looking at the associations between the CO2 tolerance and what we call trait and state anxiety. And those are in the publication process, is what I'll say. - [Andrew] Great. - So you can't really talk about that stuff as you know, until it's out. But in general I'd say like there's a reason I'm still doing it. - Great. - I'll just leave it at that. - Yeah, well assuming it's not a clinical trial, I mean, I think sharing preliminary findings is fine, as long as we highlight them as preliminary. - Yeah. - I'm not a reviewer, but I look forward to reading the paper. - Yeah, but, as you know, scientific ethically, like you need to be careful about telling people results before you've gone through that process. - Right, which is why I'm flagging this as these results are not yet passed through the peer review process. So you're hearing about it prior to peer review. - Yep. Having said that, there's enough in that field, I'm not the first one into that field. And so I'm very confident that that's a real thing. In terms of actual tracking recovery, the big picture is this. When we run through a

full analysis, when we have an athlete go through our biomolecular athlete program, we're going to run and we're going to look at three major categories, okay. Category one are what we call visible stressors. And then we have hidden stressors. And then we have recovery capacity. Any time the total stress load outpaces recovery capacity, you're either going backwards in your physical ability, or you're reducing adaptability. Now you have levers to pull here. You can reduce stress intake, or you can increase recovery capacity. Right? What we want in an ideal situation is to be able to implement the most stress possible 'cause that's the driver of adaptation. Recover from that. Now we get the most adaptation, and adaptation being simply a change. Whatever change you want it to be. That's our gold standard, right? It's pie in the eye. Some people have endogenous differences, they just recover better. They don't. There are genetic factors. But let's talk about the ones that are manipulatable. If we go to the stress side of it, you want the throttle to be pushed as far down on the ones you want stress from, and as far off of the ones you don't want stress, so that the adaptation comes in the exact area you want. And you're not burning gas in something you don't care about. Because you're just, you're taking that total stress bucket too high. Recovery capacity over there. So here's how you can do that. You can run some analytics and measure what we do with everyone, through these very comprehensive breakdowns, to figure out what's that physiology look like hidden and visible, and then what's the recovery capacity. Once we have that blueprint, we can now figure out what are the two or three things we need to track, that are these indicators of what we call performance anchors. So an anchor is something that kind of drags behind you or below you, that slows you down. The analogy being, let's say we're going down one of these amazing canyon roads, and I won't say which canyon we're in, so you can stay hidden here. And your car's going down at a certain velocity and you want to go faster. Most people's first impulse is to hit the gas, the accelerator. We want to push. Well, that's fine, but if your foot is on the brake and you push the accelerator, you might go a little bit faster. But number one, you're wasting a lot of literal gas to go a little bit faster. And two, you're burning your engine. You might, you're going to blow. The easier solution is just take your foot off the brake. You're going to go faster by just stopping yourself. Then if that's not fast enough, we can hit the accelerator. Everyone wants to just push down, right? More stimulus, more optimization. Bing, bing, bing, bing, here. Our first analytics are, where are these performance anchors? What's dragging you back? What's putting down the brake? I want to move those two or three things out of the way, and now let's see how far you

get. Oh, look at that. Your recovery capacity has gone way up. Your adaptations are happening faster now. And we can do more work because you're recovering quicker. So we're trying to figure out in those buckets, and we have a whole host of things that we measure, biomarkers and surveys, and everything else that we go through, to find out what's there. So after we've done that, now we're just going to track a few of these recovery markers along the way to figure out what's globally happening. So that could mean grip strength. I have some folks who are going to test grip strength daily. Others, we're going to look at HRV or combinations. We may look at performance metrics like a force plate. So you're going to do a vertical jump every single day. And we're going to see where that's at. We've used the tap test before, which is how many times you can tap your finger as fast as possible. It's a rough indicator of central nervous system. - In a say one minute interval. - Exactly. And this is apps you can do on, this is like you tap this finger as fast as you can. It's going to say hey, you did 60 taps today and your average is 75. - I like that 'cause it taps into, ha, no pun intended, into upper motor neuron capacity. - Hundred percent. - Because a lot of things like, like grip strength obviously, I have to send the deliberate signal to my hand to grip. But at some point the lower motor neurons are going to be taking over the majority of the work. Like the signal is probably one and done. Whereas the tapping is going to be repetitive sending of signals from upper motor neurons. - Yep. So some of the athletes I work with, we track blood every day, we track urine every day, we track ideally a combination of subjective and objective measures. Everything from how did you feel last night to environmental sensors of their bedroom. Full PSGs going on, running like actual sleep diagnostics, not an Oura ring, nothing against Oura, but like full analytics, and some of 'em it's as simple as how'd you feel today and what was your vertical jump, right? So we're going to put people in a position to succeed. We're going to figure out what's the lever that they need to pull, as well as what's their aptitude? What sport are they in? What can we realistically get away with? And some of them will take machines with them and will do blood every day and urine and all kinds of stuff, and some of them it's a lot lower. - For myself, I'm not, as I mentioned before, I'm not a big fan of devices. I'm trying to wear the wristwatch. I tend to go off feel, which is not, it's not the ideal objective way to gauge things. But part of my reasoning for this is my colleague from the psychology department, Dr. Alia Crum, has done some studies where they've given, deliberately given people false feedback about their sleep. So told people you didn't sleep very well, or they've told people you slept really well, and performance can be driven in the expected direction, based on feedback,

independent of how well people slept or didn't sleep. Now that doesn't mean you can take someone that only slept two hours, or was up every 30 seconds 'cause of apnea, and tell them they slept great, and they're going to perform great cognitive tasks. But you can take someone who slept very well, tell them that their recovery quotient wasn't very good, and their output is going to be worse. And that's my concern about a lot of devices out there, not to name specific devices. But it's still unclear to the general public, what the specific algorithms are to generate these recovery scores, right? And so many of the things that reportedly track sleep, aren't tracking sleep, - Not even close. - they're tracking heart rate and breathing, which are correlates of sleep depth, but that's different. And again, I'm not knocking those, I think the sleep trackers, if nothing else, have provided a forum whereby people are very conscious of getting good sleep. It's sort of like knowing the total chloric intake of your food, people go wow, I'm actually eating a lot more than I thought. - It's calibration. - Or less, in some cases. But often the case is that it's more. So I think for the typical person, I'm wondering whether or not, like myself, 'cause I'm not a competitive athlete or certainly not a professional athlete, competitive with myself I suppose, but no one else. Morning pulse rate I tend to take on waking. If I wake out of a really stressful dream, I might relax a little bit and then just take my pulse rate, kind of get a range, and see if it's spiking for whatever reason. I don't tend to measure grip strength, although I've heard you can just use a classic scale. - Yeah. - [Andrew] Old fashioned scale with the- - Sure. - Old fashioned. Or some other more technical device is probably good, if there's a low cost one. - Yeah, they're all low cost. - And then the carbon dioxide tolerance test. - Yeah. - So we haven't really talked about that in specific ways. My understanding of it is it's four deep slow breaths, in through the nose, out through the nose, and then a big inhale, that's max exhale, and then time duration of exhale through the nose, and then stopping the stopwatch at the point where lungs are empty. Not necessarily as long as one could hold their breath. Did I get that right? - Pretty much. - Okay, and I guess we should credit you and Brian McKenzie. - Yeah, those guys. - Yeah. - For sure. - And the folks under Brian's umbrella for really establishing this as a really good metric. When and how can I use the carbon dioxide tolerance test to gauge recovery upon waking, post-training session? - Yeah. - Would that be a good time? - Number one answer is, whatever you do be consistent. So do it under the, like any good science experiment, do it under the exact same conditions as you can. That generally means somewhere in the morning, 'cause that's when you're probably going to have the most control, most stability. So yeah, like you would take any

HRV or other metric, wake up, get under control, get stabilized, take your metric. - [Andrew] Got it. - Going to be pretty good. - Got it. Sodium bicarb. - Yeah. - Baking soda.

03:04:02 Tool: Sodium Bicarbonate

Rumor has it, and data has it, that it can actually be a pretty effective training tool. - Very effective. - Could you explain a little bit of about how it works, and how one might explore using sodium bicarb to enhance training output, in a couple of different contexts? - Yeah. So there's a handful of these ubiquitously effective supplements for performance. Sodium bicarbonate's one of them, and it's a very ingenious idea 'cause it's so simple. Effectively, muscle contraction happens because enzymatic function occurs within a fairly specific pH range, right? So if it gets extremely acidic, it doesn't like it. And so whether you're running through aerobic glycolysis or anaerobic, or anything else, all these things require, even ATP hydrolysis requires ATPases. Enzymes don't function well outside of this fairly special range. So what happens is generally fatigue, the sensations of fatigue are actually caused by some signal that hey, we're starting to run out of pH. Or we're getting in the wrong range. You're not out of gas usually, you're not too low on oxygen. You're not running low on muscle glycogen yet. You're typically going to see signs, or feel signals of fatigue way prior to that, mostly being pH issues. That being said, what if we could regulate pH better? Enter bicarbonate, right? So without going too far into metabolism, effectively what happens is you take an inhale, and you're mostly breathing in oxygen, O2. When you exhale your breathing out CO2. So the difference is you've gained a carbon somehow. Well, all of your carbohydrates in your body come in the form of long carbon chains. In fact, that's what a carbohydrate means. It is a one carbon molecule that has one water molecule attached. It's a carbon that has been hydrated. In the case of like glucose, blood sugar, let's say six carbon molecule, right? In terms of fat, which are the only two places you're going to get most of your cellular energy carbohydrates into fat, that is also a big long block in chain of carbons. So whether you're getting your energy from fat or carbohydrate, you're going to split those atoms. So in other words, you've got six carbons attached to each other, and in this part of chemistry it's exergonic. So when you break that carbon bond, so break one of those carbons off from the other, that's going to release energy. Just like if you had a pencil in here, and I snapped it and it'd go bang, and pop. I broke the bonds that were connecting that graphite to the next piece of graphite, and that released energy.

'Cause I put energy into the system, et cetera. Okay. As a result though, we've now had say five or six carbons chained together. We broke one off the end, which is not how it works, but making the point. And now you have one free-floating carbon used that energy release to then go make ATP, to then go make your muscles contract. But now you've got carbon floating around. You can associate free-floating carbon with being at a higher acidic level. It's not going to happen. The only way that you're going to go through this process is if your body says do we have an oxygen molecule available that we can bind this to immediately? Yes we do. That carbon attaches to that oxygen molecule. You can't just put CO2 in the blood because of what we just talked about. So you're going to bind it through this bicarbonate process. It's going to go through your blood. It's going to go into the lungs. It's going to go back into its carbon dioxide molecule. It's going to trans, go through the alveoli into the lungs and you're going to exhale. So you went from carbon to this bicarbonate system, back into carbon, exhale. So inhaled, O2 plants go the opposite by the way. So they're going to breathe in the CO2, they're going to cleave off that carbon, stack those carbons together, and that's how they get larger. In your blood, those six carbon chains are called glucose. If we store that in your muscle, we call it glycogen. So we take a bunch of glucose and stack it together. In a plant, we call that starch. That's effectively what it is, right? So you take a bunch of carbon from the atmosphere, stuck it all together, and that's a starch. If you want to do it in the form of fruit, we take that starch like from the ground, you put it up through the tree, go all the way up to the top, put it into the flower, break it up into these big huge chunks of starch, into little forms called fructose or glucose. That's why fruit has fructose in it, and that's why tubers and stuff have starch in them. Basically starch in an animal is glycogenesis. Okay. All that to say, if that's happening and we know that a byproduct specifically of anaerobic glycolysis meaning the breakdown of carbohydrates for fuel, typically in a very fast pace with low oxygen availability, the downside of that equation is acid production. We know that that's a problem, 'cause I started the conversation off there intentionally. So what if we could reduce the acid buildup? Now you know how pH kind of works, I went and kind of double negatives there, right? You don't want too much acid buildup. Then could we prolong and sustain energy in a more effective pace, especially in this anaerobic interval kind of environment? And again, that's important because in those things, failure is not a result of running out of fuel or oxygen. It's a result of fatigue building up way too quickly. - Is that also true for resistance training? - Uh, depends. - There's maybe more of the creatine phosphate system. - That can be an issue. It could

simply be an issue of force production. You just don't have enough force, least you're not out of energy. You just can't muster enough force. You do enough reps, then it's going to be an issue there. Creatine phosphate though would be the big winner, depending. So to come back a little bit to the beginning, and then I'll, I'm circling this all together intentionally. All right. Well, the way that we produce energy is going to be in two primary categories, anaerobic and aerobic. Aerobic meaning with oxygen, anaerobic meaning without. In terms of muscle contraction, you're pretty much talking about carbohydrates or fat. Now fat is going to be exclusively aerobic, meaning I'm going to use fat from the entire body, roughly equally. So you're doing a sprint up a hill, and your hamstrings or your glutes or your quads are on fire. You're not just going to use the fat that's directly in those hamstrings. You're going to lose it from the entire body. It has to go through lipolysis, so it's in this stored form in adipose tissue. It's got to get broken down, put into blood. Blood's going to have to go through your body, get taken up into muscle, taken up through muscle into the mitochondria. Then we're going to have to go through this process called beta-oxidation. So remember, carbohydrates and glucose especially is a six carbon molecule. Fat, if it's in the form of a triglyceride, it is a three carbon glycerol backbone, and three, tri, one, two, three, fatty acids. Three carbon backbone, and those fatty acids are just big, long chains of carbon. That's all it is, right? So we're going to break that thing down, put it in the blood, move it up, move it into our mitochondria. You can't walk those things across the mitochondria wall. They're too big. So what you have to do is cleave them off into little chunks, and it turns out we break 'em off into two carbon chunks, so we call it beta, as in two, move those into mitochondria. That can go through this little thing called Krebs cycle, or tricyclic acid cycle, and you kick out a bunch of energy out of that. You add two carbons, so as a result of that process, you're going to generate two carbon dioxides. But remember, you can only go through that process if oxygen is available, because you have to be able to place those carbons onto something. Or acid gets up way too high, too fast. This is one of the reasons why fat is a nice fuel source, but it's very slow. It takes physical time to move from the back of your shoulder, into your blood, down your hamstring uptake, uptake, uptake. In addition, it's required oxygen availability. If you need energy faster, you simply don't have the time to bring in the oxygen, transport it through, go through capillaries, exchange through a tissue, et cetera. Carbohydrate, on the other hand, is going to be stored locally in the exercising muscle cell, and specifically in the cytoplasm. - As glycogen. - As glycogen in the store there. So what's going to happen initially, your initial demands for exercise, or

for fuel, are going to come from the glycogen stored within the muscle fiber itself. It's just going to break right there, and you're going to be off the races. So you have the six carbon molecules, you're going to break it into two separate three carbon molecules. Okay, boom, that breaking provides you a tiny bit of energy, very small but some. Now you're going to take those two three carbon molecules, and you want to be able to oxidize them, 'cause that's your only next step. But in order to do that, you got to go those into mitochondria. So you got to break one of those molecules off. So then you'll be back to your two carbon molecule, just like you did with fat. That's going to go into mitochondria, and then it's going to go through the exact same Krebs cycle, two carbons, et cetera. But hold on. If you don't have sufficient oxygen, or sufficient mitochondria availability, and you're stuck at that two three carbon place, what the do you do? You have problems, right? Now we have to say, okay, wait a minute. We have three carbon molecule, and we have a bunch of this acid buildup. Now acid functionally is hydrogen. That's what pH, potential hydrogen is what pH stands for, right? So if hydrogen is building up as a byproduct of muscular contraction, and then you're having this three carbon molecule, what it can actually do is grab one of those hydrogens. And those three carbon molecules, by the way, are called pyruvic, pyruvic acid, right? If you take a pyruvic acid and you grab a hydrogen, put it on top of it, we now have a different name for it. It's called? - [Andrew] Hydrogen peroxide. - Lactate. Bingo, right? That's what lactate, or lactic acid is, right? So we've now built that up. So number one reason why lactate's not causing your fatigue, it's actually preventing it and that it does a bunch of other really cool stuff. But the point is, that system can only last so long. That gets overwhelmed very quickly. What are you going to do with the rest of this hydrogen? Well, if you started off in a normal pH range, you don't have very far to go before you've now gone into that level of too much acidity. If you start off in a more basic, and basic I don't mean simple, I mean chemistry, right, and more alkaline, then that same amount of increase in pH is no longer, now it just puts you back in your physiological range. So sodium bicarbonate, whether taken as a cream, or a powder, or baking soda, or anything else, can simply put you in a more alkaline state, even acutely. So this is something you can take right now, before your workout. You're going to delay, what we call delay the progression of fatigue. - And how would people start to approach this practice? My understanding is you can do this with common store bought baking soda. - [Andy] No question. - There's always a concern about gastric distress. - Oh boy. - That it's a very effective laxative, sometimes an unwanted laxative effect. But how would one approach

this before? Let's say I'm going to, I'm doing the mile repeats exercise. Mile repeats protocol that we talked about earlier. I'm doing that for a few months, and now I want to try the sodium bicarb approach. I'm well hydrated, hopefully I'm well rested. I'm ready to go. When am I going to drink this sodium bicarb solution? How would I make the solution? Let's say I take 10 ounces of water. - [Andy] Yeah. - How much bicarb do I want to, sodium bicarb should I put in there? Can we come up with a, is it half a teaspoon? Is it a teaspoon? - Here's how I'm going to tell you. You will thank me by starting lower. You can always go more later. - So a little pinch. - [Andy] You cannot go backwards. - How about I start with a quarter teaspoon? - Fine. Half, honestly, half is fine. - Half a teaspoon. - It's totally fine. - Dissolve that. Slug that down. I read a study recently that showed that people will hit the peak benefits of this at different times, but it's somewhere, if memory serves me correctly, somewhere between 60 and 90 minutes later. So I might want to drink it on the way to the track. - It can, it can be as low as 20. - Okay. So maybe as I get to the tracks, and so I'm going to do some warmup with some walk and jogging. - I say 45 minutes. - [Andrew] Okay. - That's just a very rough standard. But yeah, you're right, it is individualized. And you probably want to play with that a little bit. If not, just somewhere in the neighborhood of 20 to an hour. - Okay. And then the perceived and real fatigue, if done correctly, the perceived and real fatigue ought to be reduced. - Yes. - I can do more work without feeling exhausted. Will I feel less of a lactate burn? - Yep. - Done in air quotes for those listening, I realize that's a very crude way to describe a complex physiological process. Fantastic. Can sodium bicarb be used repeatedly for longer duration training? - Yep. - And if I were going to use it with weight training, for whatever reason, maybe I'm doing circuit type training or I'm doing the super set type strength training that you talked about before, push, pull, push, pull, where it's a little bit more cardiovascularly demanding. Then maybe I'd sip that throughout the workout, make sure there's a bathroom nearby, it sounds like, 'cause I do, I am aware that many people get pretty serious gastric distress. - It can happen very quickly. - Okay. Great, well it sounds like an amazing training tool. I really appreciate you sharing it 'cause I think it's, it's one that doesn't get a lot of air time these days 'cause it's been around, but sounds like it has some pretty impressive effects. - Yeah, you know what's sort of funny about that is, I mean, I get it, pop culture is what it is. But still to this day, if you want to talk about sort of your most effective general health slash performance supplementation, it's the same three to four to five. And it's because they work really well. - Without going into the chemistry of each one in the practice, each one,

'cause I definitely want to get you back to talk about nutrition and supplementation. - Oh yeah. - At some point. But I think we need a full couple of hours to get that, right.

03:17:26 Tool: Creatine Monohydrate

- Yep. - At least. If, as a teaser, would you mind just listing off the other supplements that you have found are very effective for many people? So sodium bicarb, or baking soda is one. What are some of the other ones? - Yep, we'll go kind of in reverse order. Beta alanine is another very classically effective one. Similar idea to sodium bicarbonate, so it's going to, beta alanine's going to come in, it's going to be converted and stored as what's called carnosine in the muscle. And carnosine is an intracellular buffer. So in other words, it's just going to delay the buildup of acid. So fatigue blocker, if you will. So very effective, very cheap, very safe. Well studied. The top one though, of all of them by far that has an incredibly strong safety profile. It has, it is a cheap, it is a simple form to get, has a important magnitude of effect, and is effective across multiple domains of physical health and performance. And it is because of that it is my crown jewel. It is in my opinion, without question, the Michael Jordan of all supplementation. And that's creatine monohydrate. It affects so many things. We typically think about it as it's muscle stuff, right? You've talked kind of, you quickly were talking about the creatine phosphate system. But we have to realize the vast majority of research on creatine phosphate is not in sport performance, and has not been for 20 years. It's in clinical. And it has everything from effects on the neurological system, to there have been associations to mental health and depression. And to be very clear, I am certainly not saying you can take creatine and cure anything. And I'm not saying it's going to stop you from depression or anything. But I'm saying there's a lot of research in these areas and there's a reason people are doing it. - Yeah, I completely agree. And if you're willing, I'd love to have you back for us to do a discussion on creatine in the brain, or creatine in the nervous system. - Yeah. - That would be a lot of fun, and maybe we can do a kind of a journal club in advance of that. - Yeah. - For those that don't know, a journal club is where scientists read a bunch of papers and then argue about them, discuss them, and try and extract the kind of agreed upon center of mass, if you will. I think, I've long been taking five grams of creatine monohydrate per day, mainly for the cognitive effects. - [Andy] Yeah. - I sense an effect, that's obviously anecdata, but I think there are a lot of data out there, as you alluded to. - There's enough. You're not crazy. There's enough there. And in fact,

there's enough mechanism now to understand the metabolic needs. People think, I'm a muscle guy, right, so I'm going to think about the metabolism needed to fuel muscle. But we forget cells, immune cells, red blood cells, nerve cells, astrocytes, brain, all this stuff requires energy, and it's all going through metabolism.

03:20:08 Absolute Rest

- Super interesting. We'll do the deep dive on that soon. I have a final question for you. You're involved in a really interesting, I think really cutting edge project, that I first learned about from you. I don't know of anyone else doing anything as forward thinking, and frankly as relevant to the general population, because of my interest in people getting better sleep and learning how to do that, avoiding stress and learning how to do that. Tell us a little bit about what I believe is called absolute rest. - Right. So this is something that we've been playing with behind the scenes for a long time. And this is typically how high performance stuff works, right? People want exclusivity and so this has been built. Effectively, what happened is a friend of mine, Cody Burkhart, I don't know if you know Cody, but a- - Down in Texas. - Yeah. - Yeah. - NASA. - NASA guy. Yeah I do know Cody. - Wonderful, just down the road thinker. Everyone's interested in sleep, right? And for forever I would say, we're using with athletes, but everything available tells you how you're sleeping. Nothing can tell you why you're sleeping that way. And so we got together in Boulder and then I met some of his former colleagues, computer science folks, Harvard MD, and some really impressive tech folks. And we were just thinking about an idea. And we came up with, and we started to realize the problems, right? We used first principle thinking, it's one of my favorite approaches. If you're not familiar with that, go Google that. Like that's just a recipe to solve problems, is first principle thinking. And we just started to think about like, man, all the sleep tech is there, it's real, I don't need to convince people that they need sleep. Everyone's done that. You need high quality sleep, but how can I provide solutions? And with the people I work with, I can't just tell them your testosterone's down or your sleep's down, or recovery. I need to be able to be like, this is down, and here's why, and here's our solution. That's how our high performance world works. So enter absolute rest. This is saying, okay, what are the actual nodes that go into high effective, high quality sleep? Number one is psychology. So there has to be some sort of screening diagnostic for, are you not sleeping because of simply you can't control yourself? And you've done a

wonderful job of giving people tools. Or if you can't quiet your mind before sleep do this, if you wake up and you can't go back to sleep, here are a bunch of things, right? So we have some screens that we can do, and there's some other stuff we can do to analyze. This is a psychological issue. Let's say it's not, right? You're under control. And we have different tricks we use and stuff, which I'm happy to talk about. But it's not that. Okay, is it physiology? Which is node number two. Do we know what your dopamine levels are like? Do we know what your serotonin levels are like? What's melatonin look like? What's adrenaline, what's cortisol, cortisol being the primary driver? What is this relationship DHEA, where are these things at? So we're going to measure all that and track that. We're going to measure that during the day, prior to sleep, we're going to measure that next morning, and even sometimes throughout sleep. And we're going to figure out, is this a physiology problem? If it is, then we have clear corrections. If not, we're going to go on the next step, which is, is this possibly a pathology? So you have some sort of sleep disorder. We're going to run full P, what's called PSG. So polysomnography. The exact same stuff you would get in a sleep clinic. It's a sensor that's going to go on there measuring EEG and EOG, and we're going to have muscle activation sensor to see if your legs are moving, and everything else is going on. And we're going to get a full diagnostic. And if anyone's ever done this, the amount of sleep issues that are happening in people that they don't even realize is extraordinarily high. So we're going to figure this out. One very quick example, we just did this with a professional athlete, and he was having like 280 roughly of these episodes per night. And to be categorized as an episode, you have to meet these four specific criteria. Oxygen saturation, ventilation changes, brain changes, et cetera, and he hit that over 280 times a night. And what this technology allowed us to do is figure out what position did all these things occur in. Well, in his particular case, most of them were happening, he was on his back. And so he bought a very simple like pillow basically that went on his back, that kept him from sleeping on his back. And we saw an 85% reduction in sleep awakeness issues, the very first night. Now we did that. Testosterone eventually tripled after three months by just improving sleep. And all we did is move him onto his left or right side. So huge improvements, just by understanding where the problem occurred, and why it occurred there. We didn't have to change hardly anything else. He had the basic hygiene stuff down and temperature and all that stuff. And he had his ChiliPad and all that to keep the thing cool. We couldn't fix it. Years, by the way, this took us two years of just trying everything. We're like, man. And it was just like, I wish, I wish we could get

you to sleep better. And we, I pulled out every trick I knew, and it just was, as soon as we built this [indistinct] I'm like oh my God, it's all. He's not overweight by the way, he doesn't have any, he's not iron deficient, doesn't have any of these other classical symptoms that are associated with bad sleep. Supplementation, everything we've done, a thousand protocols. That fixed it overnight. So if it's not psychology, and it's not physiology, and it's not pathology, then the last one that people don't have any idea about is environment. And so what you don't realize is we have a box. We can sit right next to your bed. You just plug it in, you don't have to do anything. And it's going to run full environmental scans. So it's going to look at the temperature in your room. It's going to look at the humidity in your room. It's going to look at the volatile organic acid. These are things that are seeping out from your mattress. It's going to look at particulates in the air, and possible allergens and things that are floating around that are closing your nose off, so you can't sleep at night and now you're mouth breathing, and you've talked a lot, I'm sure, on the previous episodes about why that's bad. It's going to look at your CO2 cloud. So we've talked, we've already set this point up, right? You're inhaling O2, but then you're exhaling CO2. Well during the day, and when we're conversing, you have quite a bit of force with that exhalation, right? But at night, it's just barely seeping out of your mouth. So what happens is, CO2 tends to cloud up and build around your face, and then you end up re-breathing that CO2. And this can cause a large number of sleep problems because you're simply re-breathing in the panic. Whether you're fully awake or just kick out of a sleep stage, the CO2 around your face is a big issue. This stuff has all been known, by the way, with the astronauts for a very long time. It just hasn't translated into the, to the commercial spaces. Of course, gone to our high performer space. So we can measure that as well. And then we can figure out like for the most extreme, we can actually come into a bedroom and build an entire sleep optimization set up, and control the entire thing. But for most folks, the minimum we can do is run full diagnostics and check off is this environmental related, is it pathology, is there something else? - So is this a commercial device that people can eventually access? - It is now. - So where can people learn more about absolute rest? - Absoluterest.com. - Very cool. And just for our full disclosure, I wasn't aware that you had done this prior to today, what you'd mentioned. I always like to ask people, scientists or otherwise, I always love to ask what are you most excited about lately? And this sounds like an amazing technology. - And just to be really clear, that's not like something we're working on. That's landed. - That's landed. - We're ready to go. - Great. Well, and that's one of the things I appreciate about

you is that you're willing to sometimes speculate, but you always say it's speculation. But in general, you seem like the kind of guy where if you're going to be public facing about something, if you're going to make a statement, there's got to be quite a bit behind it. You're not going to allude to the, in 10 years, we might be able to do this. Or in five years. You're a very data-driven kind of guy. - Yeah, well, the people I work with, we need answers, right? We don't have that timeframe. And we typically have like, hey, we start the season in four weeks. - Yeah. - So that's just where I'm at. - Well, as I said, I appreciate that about you, but it is but one of the many things I appreciate. I think the listeners and I can well appreciate on the basis of today's discussion, what a enormous wealth of information you are. How clear and potently you communicate that information. And also how you can take a huge cloud of information and still distill it into protocols that ought to work for 75% of people, 75% of the time, which is an immensely valuable thing to do. So for me and from the listeners, I just want to say, thank you so much for taking the, several now hours, I lose track of time, which reflects all good things. Several hours to take a break from teaching, take a break from research, take a break from the other important commitments of your life, and really share with us all this incredible information. I'm so, so grateful. - My pleasure, man. I'm glad we finally got to connect. This has been a long time in the making. - It has, and I'm going to bring the breathing protocols to my training. I'm going to start doing more of the endurance type and interval type training. I'm going to start moving when I do heat, I'm going to start moving when I do cold. I might even start throwing some sodium bicarb into, very small amount of sodium bicarb into some water before I train.

03:29:08 Zero-Cost Support, YouTube Feedback, Spotify, Apple Reviews, Sponsors, Patreon, Thorne, Instagram, Twitter

And listen, Andy, Professor Andy Galpin, thank you ever so much. - My pleasure. - Thank you for joining me today for my discussion with Dr. Andy Galpin. If you'd like to learn more about his work, and learn further information about exercise science from Dr. Galpin, please find him on Instagram at Dr. Andy Galpin. You can also find him on Twitter at the same handle, Dr. Andy Galpin, spelled with one L. And if you're learning from, and or enjoying this podcast, please subscribe to our YouTube channel. That's a terrific zero cost way to support us. Please also subscribe to the podcast on Spotify and Apple, and on Apple you have the opportunity to leave us up to a five star review. If you

have questions or comments about the podcast, or you have suggestions about future topics or guests that you'd like to see me interview, please put that in the comment section on YouTube. We do read all the comments. In addition, please check out the sponsors mentioned at the beginning of today's podcast. That's the best way to support this podcast. We also have a Patreon, it's patreon.com/andrewhuberman. And there you can support the podcast at any level that you like. During today's conversation, and on many previous episodes of the "Huberman Lab Podcast", we discuss supplements. While supplements aren't necessary for everybody, many people derive tremendous benefit from them, for things like sleep, and focus, and energy, and many other features of our physiology, and mental functioning. There are some important issues to consider when considering supplements. One of those issues is the quality of the ingredients. For that reason, we've partnered with Thorne, T-H-O-R-N-E, because Thorne supplements have the highest possible standards with respect to the quality of the ingredients they include. If you'd like to see the supplements that I take, you can go to Thorne, that's T-H-O-R-N-E dot com, slash the letter U slash Huberman, and there you'll see the supplements that I take, and you can get 20% off any of those supplements. If you navigate further into the Thorne site through that website, thorne.com/u/huberman, you can also get 20% off any of the other supplements that Thorne makes. If you're not already following Huberman Lab on Instagram and Twitter, please do so. There I discuss science and science-based tools, some of which overlap with the content of the "Huberman Lab Podcast", but much of which is distinct from the information covered on this podcast. Thank you once again for joining me for my discussion with Dr. Andy Galpin, and as always, thank you for your interest in science.