

Welcome to the Huberman Lab guest series, where I and an expert guest 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 marks the second episode in the six episode series with Dr. Andy Galpin, a professor of kinesiology at Cal State University Fullerton, and one of the foremost world's experts on the science and applications of methods to increase strength, hypertrophy, and endurance. Today's episode is all about how to increase strength, speed, and hypertrophy of muscles. Professor Dr. Andy Galpin. Great to be back. Last episode you told us about the nine specific adaptations that exercise can induce, everything from strength and hypertrophy to endurance, muscular endurance, so on and so forth. And you gave us this incredible toolkit of fit tests for each of those adaptations so that people can assess them for themselves and then, of course, improve on each and every one of them if they choose. By the way, people can access that information simply by going to the first episode in this series with you. And it's all there and timestamped, and I highly recommend people do that. Today we're talking about strength and hypertrophy. And so right out the gate, I just want to ask you, why should people think about and train for strength and hypertrophy? And that question is, of course, directed towards those that are trying to get stronger and grow bigger muscles. But I know that many people out there perhaps have not thought about the benefits of strength and hypertrophy training and how beneficial it can be, not just for people that want to get bigger biceps, et cetera, but that have other goals, longevity goals and health goals unrelated to what most people associate with hypertrophy. So what are the benefits of training for strength and hypertrophy, for the everyday person, for the athlete, for the recreational exerciser and so on? There's a wonderful saying, I think it was Bill Bauerman, one of the founders of Nike, and he always said, if you have a body, you're an athlete. And I think that's very important for people to understand because one of the major disservices we've done in this field is convince people that things like strength training are for athletes or for growing bigger muscles, and cardiovascular training are for things like fat loss and heart health. And that is a tremendous disservice because it puts a lot of unnecessary barriers and leads to a lot of false assumptions and then therefore, poor actions. Classic examples of this are people who are resistant to strength training because they don't want to put on too much muscle, people who only perform one type of exercise because they want, say, fat loss, or they're in it for longevity and health and they're not worried about being an athlete. And so, right out the gates, we can actually draw back a little bit to what we were our previous conversation when I walked you through the history of exercise science. And the reason I did that is to help you understand these are the railroads that you're running down and you don't even realize it in terms of everyone thinks of strength training and they immediately default to our principles to optimize muscle growth. And that's not the only adaptation one should be after with strength training. When we think of endurance training, we immediately default to things like, again, cardiovascular health or fat loss or things like that. What I really want to do across this entire series and conversations is to just break that immediately. Talk about all the other things that you can do with your training and so that people can be comfortable and confident in doing an optimal training program for whatever goal they have, whether that be specific, like growing muscle or nonspecific, like just feeling better, having more energy, being more prepared for life and longevity. And so to directly answer your question, we could do 100 episodes on the benefits of exercise and we could run all the way from mood and focus cognitive tasks to a better immune function. You'll get less colds, you'll fight them off more effectively to mortality, right? So some of the strongest predictors of how long and how well you will live are exercised. However, there are independent benefits that come from just endurance training, and there are independent benefits that come from strength training. And so to just give you one categorically, the way that you want to think about this is resistance exercise. And strength training is the number one tool to combat neuromuscular aging. You cannot get that through any other form of exercise besides heavy overload strength training. And we can walk through in detail what that is. But that is reason number one. In general, human movement is a function of number one, some sort of neuromuscular activation. So nerves have to turn on. The second part is muscles have to contract. And the third part

is those muscles have to move a bone. All right? If you want to be alive and you want to live by yourself, you have to be able to engage in human movement. If you have any dysfunction in the neuromuscular system there, then you're not going to be able to do that. And again, as I mentioned, the only way to preserve that or fight that loss of aging is to strength train. So people will tend to hear numbers like you lose about 1% of muscle size per year after age about 40. And that's true. However, what they don't realize is you lose about two to 4% of your strength per year. So the loss of strength is almost double that. The loss of muscle mass. With aging, muscle power is more like eight to 10% per year. And so we can very clearly see the problem you're going to have with aging is not going to be preservation of muscle, although that is incredibly important. It's going to be very specifically preservation of muscle power and strength. And why that really matters is your ability to again stand up and move, your ability to catch yourself from a fall, your ability to feel confident doing a movement that is a function of muscle power more than it is muscle size. And so functionality is really what we want to be right. You want to be able to do whatever you want to do physically and feel confident in doing that as you age. That's going to only be obtained through strength training. So is it appropriate to say that training for strength and hypertrophy is also a way to keep your nervous system healthy and young? Yeah, absolutely. It is the only exercise route we have for that. If you look at just basic numbers like motor units, you're going to see that older individuals have like a 30% to 40% reduction in total motor units. So when you say older, approximately what ages are you referring to? Because I know many people out there, such as myself, are 40 and older, but I know many of our listeners are in their 20s, maybe even in their teens. And I can imagine that people that start doing strength and hypertrophy training younger will afford themselves an advantage over time, but that everybody should be doing strength and hypertrophy training for as much of their lifespan as possible. That's really the message that I'm getting. So if somebody is, for instance, 45, would that fall into the bin of older? You're going to start seeing decrements past again around that age of 40 or so. Now, there's a lot of genetic variation there and a lot of other things go into that equation, like your sleep and your nutrition, but that's a fair number to sort of think about. One actually response is it's actually sort of counterintuitive. The wonderful thing about strength training is you don't actually have to start at a young age. In fact, I was reading a paper this morning because of our previous conversation, it was in over age 90. So these are folks 90 plus and they saw improvements like 30% to 170% in things like muscle size and hypertrophy over a very short period of time. I think it was twelve weeks. So you don't actually have to start. There are some adaptations that you're going to need for health that you really need to start in your twenty s. The reason I like to mention that is because if you are listening and you are 50 and you're like, oh shit, I haven't been strength training, you're not toast. You should absolutely start now. But you're going to be able to get to a fantastic spot very quickly. Similarly though, if you are 20 or 25 and 30 and you aren't lifting, there are still many reasons why you should do that now. And I'd like to point that out because a lot of folks will be like, oh my gosh, they said I have to do it when I'm 20 or 25 or I'll be sort of screwed. And that's not the case at all. There's really no age limit on this. In fact, there's actually interesting data that just came out showing that this reduction in muscle strength and hypertrophy that I sort of talked about is basically ameliorated with a preservation of activity. In other words, you don't lose these functionalities because of aging. You lose these because of a loss of training to state that, again, you don't lose these because of some innate physiological thing that happens with genes become less sensitive or you lose functionality. You pretty much can describe the loss of function of strength and muscle in aging exclusively because of a loss of training and nutrition and anabolic resistance and some other things. So you can do a lot more than you think when it comes to maintaining high quality muscle. And that's really important to point out. I'm reminded of the words of the great Sherrington. He won the Nobel Prize. Physiologists. I guess the neuroscientists try and claim him as a neuroscientist because he worked on the nervous system. The physiologists claim as a physiologist, he is 100% a physiologist. I would call him a neuroscientist.

Maybe we can argue about this later. We will. But I think one of the key things

that Shearington pointed out was that and I believe the quote was that movement is the final common path. And what he was referring to was the fact that a significant fraction of the brain itself is devoted to our ability to move and our ability to engage in resistance type movements. And that resistance type movements and the continuation of movement throughout the lifespan is what keeps the brain young and healthy and vital. And there are so much data now to support that. But I'm so grateful that you brought up early this fact that there's a neuromuscular link because I think a lot of people think about musculoskeletal. They forget that the nervous system is really in charge of the strength of the muscle contractions and the types of muscle contractions that occur. I'm certain we're going to get into that in a lot of depth today. You're close there. We're not totally right, but we're close. Okay, well, I look forward to being corrected and to achieving the precision that you're known for around that discussion. So if we are to step back and say strength training and hypertrophy training is critical for people of all ages for developing and maintaining the neuromuscular system and for our ability to function in the world not just offset injury, but the ability to pick things up and move, et cetera. What are some of the other things that strength and hypertrophy training can provide? I know a lot of people use strength and hypertrophy training for changing their aesthetics. What is your sense about its potency for changing aesthetics? As compared to, say, cardiovascular exercise. Yeah. The mantra I always like is the reason you want to exercise is threefold, right? You want to look good, feel good, play good. That comes from sport, comes from football specifically. We always say that. And what that means really is you want to look good. People want to look the way they want to look, whatever that means to them. And there are any versions of what you feel to be aesthetically pleasing, and that's totally irrelevant. But people want to look the way they want to look. Number two, you want to be able to feel good. What's that mean? You want to be injury free. You want to have energy throughout the day. You want to be able to execute anything you want to. So whether you want to go surf in the morning, you want to play racquetball or you want to hike or you want to do all three of those in one day, you should have the ability to do that. And then you want to play good, which means you should be able to execute any activities that you want to execute, whatever that means. All right, so backing all up. What's that got to do with your question? One of the major benefits of strength training is the responses tend to happen extremely fast. So you can see noticeable changes in muscle size, certainly within a month, absolutely within six weeks. And so we have this wonderful feedback loop that sort of tells you, am I doing this incorrectly? Oh, my gosh, yes, I am. Also, it's very addicting. The feedback, the response, the physical changes, whether this is actually zero, two, or three, look good or feel good, play good, or it's even just part one, you're starting to see that when you compare that to things like fat loss, that journey tends to be longer. It's more difficult. It's more reliant upon other factors like nutrition, et cetera. Strength training is really about like there's some very minimal nutrition requirements. Outside of that, it comes down to the training and the feedback is immediate. That's powerful because if you look across the literature on exercise adherence, you'll see that is in fact the number one predictor of effectiveness of any training program. So what that means is if you were to put any variable possible and figure out what is going to determine whether or not this program works, this is what we typically call the methods are many and the concepts are few. So the methods of exercise, the methods of strength training, the methods of hypertrophy training, which we'll talk about, are infinite. However, there are only a handful of key concepts that you have to achieve in order for that program to work. Adherence is one of them and again, is often the top one. So you need to do something. You need to do something consistently. When you are getting that feedback and you're seeing results in your appearance immediately. And you see that every single day. Every time you take off your shirt or every time you look in the mirror, you see that result. That tends to drive adherence really powerfully. So it's important to give people wins, especially people who are not maybe like you and I, who are like, I'm going to lift weights and I'm going to exercise no matter what the rest of my life, because I just love it. Not everyone's like that. And so giving them a little bit of carrot of success, and if you can achieve that in, say, three to four to five weeks already, it's very powerful tool. Before we begin,

I'd like to emphasize that this podcast is separate from my teaching and research roles at Stanford. It is also separate from Dr. Galpin's teaching and research roles at Cal State Fullerton. It is, however, part of our 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, we'd like to thank the sponsors of today's podcast. Our first sponsor is Momentous. Momentous makes supplements of the absolute highest quality. The Huberman Lab Podcast is proud to be partnering with Momentous for several important reasons. First of all, as I mentioned, their supplements are of extremely high quality. Second of all, their supplements are generally in single ingredient formulations. If you're going to develop a supplementation protocol, you're going to want to focus mainly on using single ingredient formulations. With single ingredient formulations, you can devise the most logical and effective and cost effective supplementation regimen for your goals. In addition, Momentous supplements ship internationally. And this is of course important because we realize that many of the Huberman Lab Podcast listeners reside outside the United States. If you'd like to try the various supplements mentioned on the Huberman Lab podcast, in particular supplements for hormone health, for sleep optimization, for focus, as well as a number of other things, including exercise recovery, you can go to Live momentous spelled O-U-S so that's Livemomentous.com slash Huberman. Today's episode is also brought to us by Eight Sleep. Eight Sleep makes smart mattress covers with cooling, heating, and sleep tracking capacity. I've been using an eight sleep mattress cover for about the last eight months, and it has completely transformed my sleep. I'm sleeping about the same amount, but I'm sleeping far deeper, and I'm now getting the proper ratios of so called rapid eye movement, or REM sleep, and slow wave sleep, and waking up feeling far more recovered mentally and physically. The underlying mechanism for all that is very straightforward. I've talked many times before on this podcast and elsewhere about the critical relationship between sleep and body temperature. That is, in order to fall asleep at night, your body needs to drop by about one to three degrees in terms of core body temperature, and waking up involves a one to three degree increase in core body temperature. With eight sleep mattress covers, you can adjust the temperature of your sleeping environment to be one temperature at the start of the night, a different temperature at the middle of the night, and a different temperature as you approach morning, each of which can place you into the optimal stages of sleep and have you waking up feeling more refreshed than ever. If you'd like to try Eight Sleep, you can go to Eight Sleep Huberman and check out their Pod Three cover and save \$150 at checkout. Eight sleep currently ships in the USA, Canada, United Kingdom, select countries in the EU and Australia. Again. That's eight sleep huberman to save \$150 at checkout. Today's episode is also brought to us by Levels. Levels is a program that lets you see how different foods and activities affect your health by giving you real time feedback on your blood glucose using a continuous glucose monitor. Many people are aware that their blood sugar, that is, their blood glucose level, is critical for everything from fat loss to muscle gain to healthy cognition and indeed, aging of the brain and body. Most people do not know, however, how different foods and different activities, including exercise or different temperatured environments, impact their blood glucose levels. And yet blood glucose is exquisitely sensitive to all of those things. I first started using Levels about a year ago as a way to understand how different foods, exercise and timing of food relative to exercise and quality of sleep at night impact my blood glucose levels. And I've learned a tremendous amount from using Levels. It's taught me when best to eat, what best to eat, when best to exercise, how best to exercise, and how to modulate my entire schedule from work to exercise and even my sleep. So if you're interested in learning more about Levels and trying a continuous glucose monitor yourself, go to Levels Link huberman that's Levels linkhuberman. Let's talk about strength and hypertrophy. If you would please remind us what strength and hypertrophy are in terms of the specific adaptation they represent. What I mean by that is, when somebody is training for strength, what are they really training for? Obviously, it means the ability to move more weight, but I know that it includes a number of other things as well. And when one is training for hypertrophy, for the growth of muscle fibers, what does that represent? Because I think if people understand that, they will far better understand the methods and

protocols that are going to be best for strength and hypertrophy at its core. You've basically described it. When we talk about strength, we're talking about an actual function. So can you create more force across a muscle or muscle groups or total movement? When we talk about hypertrophy now, we're specifically referring to just an increase in size. There's no actual mention of function. So a muscle can grow larger without actually technically being stronger. For a number of reasons. However, there is a strong relationship between strength and hypertrophy. So a lot of the times in the general public, in the lay conversations, we sort of lump those two things in as the same thing. And so we have to recognize people who are new to training or people even are intermediately trained. There is a huge overlap between strength and hypertrophy. Once you get past that, though, they become disentangled. And a good example of it is this if you look at the strongest people in the world, this would be people who compete in the sport of powerlifting. That's a true test of maximal strength. So it is a deadlift, a bench press and a back squat and you're going to do a one repetition max on all three of those. And so whoever wins is the person who lifted the most amount of weight one time. That's it. It's not like World's Strongest Man where it is how many reps can you do in a row or your time, right? Is a true maximal strength test. And you compare those to, say, bodybuilders. Now, both of those individuals are strong and both of those individuals have a lot of muscle. However, it is extremely clear the power lifters will be significantly stronger than the bodybuilders on average, right? There are individual exceptions, but we're just talking collective averages and the bodybuilders will have more muscle than the other ones. In addition, whether you look at Olympic weightlifting or power lifting or World's Strongest Man for that matter, there are weight classes. And the reason is, as you go up in weight classes, you will always see the world records go higher and higher and higher, right? So you can clearly get stronger without adding any muscle. However, there's a point where you simply have to add more mass to get a higher number. And that's why we have weight classes in those sports and in combat sports and lots of other things. So there's a lot of confusion, right? Because people think, man, either these are the same thing, or if I want to get stronger, I have to get bigger, which is not the case at all. Another misnomer here is I can't get stronger unless I add muscle. That's not true either, right? It's a similar idea. So what I'm saying is you have the ability to do whatever you'd like. If you'd like to get stronger and add muscle, great. If you add muscle, you're probably going to bring some strength along for the ride. However, if you want to get stronger and you don't want to add muscle for any reason, personal preference on aesthetics, whether you're in a weight class and you simply can't afford it, it is quite easy to get stronger and not add much muscle mass either. And so differentiating these two things is one of them is simply a measure of size and the other one is a measure of force. And when we talk about strength, what we're really talking about are two unique components. Component one is what I call the physiology. So what is the ability of the neuromuscular system? What is the ability of the muscle fibers to contract and produce force? The other one is what we call mechanics. And mechanics is simply things like it's minutiae down to how long your femurs are relative to your tibia or other things like this is biomechanics, this is also technique, this is skill, this is how smooth do you feel? This is are you firing the right muscle group in the right sequence and order? And all of these things play into strength. So somebody who maybe has more force capability in their muscle fibers, but their technique and the movement is worse, may lose in a competition. Or somebody again who's like if you go into the world of speed and power, especially, you'll hear a lot of people talk about the rhythm and there's just a certain rhythm that has to happen if you want to jump as high as possible or run as fast as possible. But that's all mechanics at this fundamental level. So when we look at hypertrophy, it's just still simply about how big the muscle is. So those are really the similarities and distinctions between strength and hypertrophy. When strength improves and when hypertrophy increases, is there also involvement in the ligaments and tendons? That is, of course the ligaments and tendons are involved in the movements. But do ligaments and tendons themselves grow and or get stronger? This field is really difficult because connective tissue is not vascular. And so their plasticity is significantly lower than skeletal muscle. In fact, if you look across all the organs, skeletal

muscle is one of, if not the most plastic, meaning it's the most pliable, the most responsive, the one that's going to adjust. It's paying attention to everything that's being said in the body. You cannot change blood pressure or PH or macronutrients floating around without muscle knowing about it. In fact, this is why we call muscle an organ. People don't tend to think about this. If you were ever on Jeopardy. And they ask you that question of like, what's the biggest organ system in the body? People tend to say the skin muscle is actually the correct answer. All right, well, I'm going to cite you when I get it. You'll probably get it wrong on Jeopardy. I don't have any immediate plans to go on Jeopardy. But who knows. Oh, there you go. Celebrity Jeopardy. Andrew Huberman wait, I don't know about the celebrity part, but Jeopardy. Would be fun. But I will say the muscle. And if you get a phone call on Jeopardy. I don't know, I haven't seen that show in a very long time, maybe ever. Then I'll call you. But that makes sense. Muscles would be the largest organ system in the body. The reason I'm saying that is so muscle is both listening and talking. It is controlling the immune system a lot. It's controlling blood glucose regulation. It is the central depot for amino acids, which are needed to do things like regulate the immune system, build any new red blood cells. A lot of this stuff is coming from skeletal muscle. So when we say organ, by the way, that's actually like a physiological definition. So something that's communicating to either another organ itself or throughout the system. So it's listening and it's talking. Connective tissue is not the same way. And so we do see adaptations. With strength training in connective tissue, it's just much lower. It's difficult to measure effectively. What we know now is you're going to have a combination of adaptations throughout the connective tissue. It is beneficial. This is probably one of the major reasons that strength training reduces injury risk, which is very, very important, because people who tend to want to pick up an exercise routine after, say, ten years, the classic cliché is like, I played all these things in high school, then I went to college, got a job. Now I'm 25 or 35 or whatever, and you sort of want to jump back into what you did when you were 20. Well, there's no tissue tolerance left. And what we almost always mean by that is connective tissue. The tolerance in there is not ready for the load you're about to handle. And so you go through some movement and then boom, sprains tears, even like the more significant ones are on Achilles tear, which is going to really sideline you. So those are some of the problems. And we know strength training has a large role in injury reduction, for stress and strain and overuse injuries. And that's specifically coming for the connective tissue adaptations. Again, the difficult part here is it's very hard to assess. When I was a doctoral student, we played around with patella tendon biopsies, so I actually had one. There's a little piece of your patella tendon missing. Yeah. Because your own lab now, I've probably had I don't know how many hundreds of biopsies I've performed on people. Probably well over a thousand. Certainly well over a thousand. I've probably had 35 or 40 done them myself. There's no problem here. I have no scar tissue, I have no loss of function. And I've stuck needles in every leg, like, all over myself. Right. Quads, my soleus gastroc all up. Taking tissue out. Yeah, you go with the needle. Looks like a pen, basically. And you're live and you go in and grab a chunk and you pull it out. Can I come to your lab and get biopsy? Absolutely, yeah. Looking under the microscope, it'll just look like the molecule. Caffeine there's a mutual friend of ours who came down and did that. He's a big, big gentleman, big into lifting, very into strength training. And he went through that experience, and he was like, oh, my gosh. It was not what he was hoping to get. He. Actually had unbelievable muscle morphology. His fibers were the diameter of muscle fibers is extremely large. It's one of the biggest cells by volume in all of biology, skeletal muscle in human. How large? Can't help myself. Millimeters. Well, so you have length and then you have width, right. So lengthwise, they can be extraordinarily long. The classic example is like your sartorius, which is like the front of your hip to the inside of your kneecap. Theoretically, those cells can run the entire length, which would be one muscle fiber running that thing. If I were to do a biopsy on you and I pulled that tissue out, I could actually pull an individual fiber out with Tweezers and hold it up and you could see that whole muscle cell. Yeah,

I'm definitely not allowed to get biopsied. You'd be stunned how big they are. Anyways, his was the size of a rhino. So the diameter of his now he has a well

documented assistance in the area of muscle growth, we'll say. But yeah, those can be large. So what were we even talking about there? Well, I was asking about tendons and ligaments because I'd like to understand the various tissues and organ systems that adapt when one gets stronger, when muscle tissue grows. And I do want to ask about bone, and here I'm not referring to bone mineral density. What I was going to ask is whether or not bone itself can grow and get stronger. And the reason I'm asking is there's a favorite result of mine? I have about 3800 favorite results, 3000 pet peeves and 3800 plus favorite results. But one of my favorite results is from Eric Kendall's lab at Columbia. Eric won the Nobel Prize for learning and memory, and his laboratory got really into the effects of exercise on learning and memory. And they had this incredible result, which is that load bearing exercise stimulates the bones to release something called osteocalcin. Excuse me? And then osteocalcin acts as more or less a hormone, travels to the brain and enhances the memory systems in the brain by enhancing neuron health. That's the basic crux of the studies. There were several of these and the moment I saw the first of those studies I thought, well, here's another reason to do resistance type exercise and not just aerobic exercise. And then it brings to mind whether or not bones themselves get stronger when we do resistance training. I don't know the answer to that. Yeah, that's very clearly demonstrated and we've known that for many decades. You have a diminishing ability to do so with age particularly. You need to do this in your teens and 20s. This is where you're going to have the largest ability to enhance bone mineral density and it's particularly responsive to axial loading. Now, I'm a muscle guy, I'm not a bone specialist. So we would have to consult somebody who can give you more position here. But that you explain axial loading. It's up and down. It's vertical. Okay. So it's almost like a cylinder putting weight on the small end of the cylinder. On both small end of the cylinders, yeah. If someone doesn't do this in their 20s or teens, however, can we assume that some degree of positive change will occur if they do resistance training, even if it's a small fraction? The answer is yes, it is small. We have worked with a number of women in our rapid health program that come in, and they are in their twenties and they're in their thirties, and they have significant bone marrow density problems. And eight months later we can see noticeable changes that are outside of the measurement error of a DEXA. Positive changes. Positive changes, correct. And if you worked with there are many physicians that specialize in this area, you're going to need a nutrition here. Strength training alone is probably not going to get you there, particularly with women, because you have to figure out why. And there's a lot going on with the physiology and biochemistry. So you probably almost surely needed to have some blood chemistry done with that. You have to figure out what's going on menstrual cycle wise. In fact, oftentimes what we'll do for our women very specifically is we use a thing called the rhythm plus a 30 day test. So you can actually do a salivary test across the entire menstrual cycle and you can take samples. It's about every other day. So you'll get 15 or 16 samples and you get a really beautiful picture of what's happening hormonally across the entire menstrual cycle. And that's really, really important because typically for women, if you get a single sample or simple time point, whether it's salivary, urine, or blood, you can have well like order of magnitude difference in any number of metrics because of what phase you're in. This is one of the many reasons why it's been such a challenge to do a lot of physiology research with females. Some metrics change throughout the menstrual cycle, others don't. Like strength is a very good example. I can strengthen and I can do a one rep max test on a woman at any point. I don't have to do that at a certain phase of their menstrual cycle because the evidence, I think, is pretty clear at this point, that number won't change. So I have no qualms, including females in any of my studies where strength is an important dependent variable because I don't have to adjust around menstrual cycle. Other factors, like anything in blood, anything hormone related, you're going to have to automatically account for it. So what I would say is those folks should absolutely work with a qualified physician. And you're going to have to get some nutrition supplementation potentially, and then maybe even some other stuff going on to make that even more complicated. If you're on any form of birth control or not, that's going to change the entire equation, especially if it's a hormone based birth control. So it just gets really complicated. To answer it, though, you can see adaptations, they are

significantly diminished relative to if you would have started in your teens and 20s. But there is hope. You just need to work with somebody who specializes in that area. So for both men and women, boys and girls, what are the major adaptations that occur to underlie improvements in strength? And if you would, if you could just provide a bullet point list of that and then we can dive into each of those in detail. For instance, are nerves getting more efficient at firing? Are bones enjoying adaptations in different bone connective tissue relationships that underlie strength? I have to imagine all of these things are happening, but what are the major changes that are occurring in those organs and organ systems that reflect someone's ability to, on one day lift 100 pounds and then a week later to lift 105 pounds? Now I'll try to keep this condensed. Again, this could be an entire university course. I will also try to give you a little bit of bones here. So normally as a muscle guy, I take all the credit in muscle. Turns out the nervous system gets a little bit of credit too. Here. Thank you. So as we walk through it, just as a big picture, if we think about, again, what causes human movement, basically everything along that chain will improve the strength training. And I'm not really being using too much hyperbole there. It's quite impressive. So just going from the nervous system side of the equation, what has to happen for human movement is a nerve has to send a signal through a motor unit. Now a motor unit comes down and innervates multiple muscle fibers. So if you think about your actual muscle, it's not a thing. It is a component of many individual muscle fibers. So you've got millions, if not more. Think of it like a ponytail. So we collectively say ponytail and you think of it as like one thing, but really a ponytail is a combination of tons of individual hairs. Muscle is the same way. So this motor unit comes in and innervates a lot of different muscle fibers. Now, every one of the fibers in a motor unit is generally of the same fiber type. So fast twitch or slow twitch, and they are not laid out next to each other in the muscle. They are spread out across, horizontally, vertically, as well as closer to the bone and further to the surface. So they're moved throughout the entire way. And this is what allows you to have smoother contractions and you don't have specificity and things like that. So we see improvements from the neuromuscular side, like firing rate. We see synchronization improvements that are coming in. You also see improvements in things like acetylcholine release from the presynaptic neuron, so you're getting it faster. We see calcium recycling is improved back to there. So in order for without walking into too much of the biochemistry, in order for a signal to go from nerve to muscle, there's a little bit of a gap, there's a physical space that happens. And what happens is you release this molecule called acetylcholine. This goes into the postsynaptic cleft and then that actually binds to a receptor. That receptor actually opens up a door that lets sodium in. That's really what's happening. So it's not acetylcholine. Well, that acetylcholine then sits on that receptor site. It's broken down, put back in and recycled back up in the presynaptic nerve site. The faster you can do that, the faster you can recycle that signal. And so almost everything that I described in that entire system improves and has been shown to increase with tranny. So that alone is given to give you benefits. We haven't even walked into getting from an electrical signal now into an action potential which is going to cause a muscle contraction. So getting from nerve into the muscle, we see everything from improvements in what we call contractility which means the muscle fiber themselves can produce more force or more velocity independent of muscle size changes. This is another component when we ask like, well, how is that I got stronger without getting bigger? Well, in the muscle fiber itself, its ability to contract force increases. And this is because we have everything like the Sarcoplasmic reticulum which is the place that stores and releases the calcium, which is what's needed for this entire cross bridge interaction from the myosin and actin to happen. I know a lot, I just lost a lot of people. But you can go look at some of these images. The Sarcobasma chicken gets activated more, it gets more sensitive. It is better at releasing calcium, bringing it back in and doing it again. The bond between the cross bridge, the myosin and actin gets stronger. The calcium affinity is the phrase that we use there, increases. So we're literally walking through almost the entire process

of skeletal muscle contraction here and every step along the way we see improvement. So that net result is we see again, more force production independent of any change in size, independent of any increase in contractile

units. We didn't add anything to the equation. We didn't change size. We did nothing but improve efficiency effectively independent of that. Now we can actually start talking about changing muscle fiber type. So we can change our fibers from a slow twitch fiber to a fast twitch fiber. That alone is going to give you more force production, again, independent of size. Fast switch fibers tend to be larger than slow twitch fibers, but not always, especially in the presence of endurance training. So if you do a lot of consistent endurance training, it's very common for us to find soul church fibers that are as similar size, if not larger, often very often larger than the fast touch fibers. If you do a lot of slow fibers, big, slow, very metabolically effective fibers. So extremely fatigue resistant. So it's not a bad thing to call them slow. We tend to say fast and slow. And slow has this negative connotation, but it's a quite healthy fiber type to have outside of that. Now, we haven't even gotten into things like penation angle. So this is the angle at which your muscle fibers interact with your bone. So we tend to think about this as like a muscle fiber is pulling on a muscle. Well, some of these are oriented at almost a 90 degree. So a fiber runs perpendicular into the bone and some of them are closer to like a 45 degree and some of them are closer to almost parallel. And that confers a lot of unique mechanical benefits. So in one area it's actually going to increase force production. You go the other direction, increases velocity. And so we have all kinds of changes in the angle at which the muscle inserts into the bone. Now, we're already in the mechanic side of it, right? So we've influenced how effectively it pulls. And with any of these things, it's always a give and take. So you're going to give up, in the case of panation angle, you're going to give up strength, but you're going to increase shortening velocity. Or if you want to increase the velocity, you're going to give up sort of the strength. We haven't gotten to any of the energetics at all. So we haven't talked about increasing storage of phosphorcreatine, which is the energy system needed to power that muscle contraction at the fastest possible rate. So we could continue to go as long as you want here, but hopefully you're getting the point of a little bit of the adaptations that occur. The reason I want to actually why I think that stuff is important, to bring it back, maybe for some musters. I know I took you on a journey there and you're just like, what the hell just happened? That matters? Because again, this is the specific explanation for how is it possible that I got stronger but I didn't get bigger. And this is also why strength and hypertrophy are intertwined and are heavily overlapped, but are not necessarily the same thing. So, for example, we can increase muscle size and actually reduce strength because of what's called lattice spacing. So what happens is you have to kind of remember your muscle fibers are these long cylinders and the way that they contract requires an optimal space. And so what happens is you have this molecule called actin and you have this molecule called myosin. Myosin sits in the middle and there are six actin that surround each individual. Myosin in a three dimensional circle here. So you got a myosin in the middle that house all these globular heads and they can reach up and grab an actin. And again, there are six sort of around them, right? Well, one of the things that can occur is if those actin are too close together. So imagine my hands, I'm reaching out and doing a giant t, right? So I'm horizontal up there. Well, if my fingertips are the tips of the myosin and I'm trying to reach up and grab an actin, and I want to pull those actins closer to my face, well, those actins stack on top of each other and that's what actually makes your muscles grow up. Like if I flex my bicep, it actually grows up three or four inches because you're stacking these sarcomeres, or what they're called, on top of each other. All right, great. Well, if I'm reaching out to grab them and the muscle is stretched too far, I can't actually make that strong of a connection. It would be like if I reached out and grabbed something, but I can only reach my longest fingertip on it. When I go to contract, I can't make that strong of a contraction because my grip is weak. My grip is going to break before I reach my strength limit. If I'm too close, there's nowhere to go. I'm already as close. So if you actually disrupt that lattice spacing too much, you can actually lose a little bit of strength. So it's not that getting bigger will ever make you weaker. It's simply that you're not optimizing for strength, you're simply optimizing for size. And so that can explain a little bit of the discontinuity between growing and performance. I'd like to take a brief break and acknowledge our sponsor, Athletic Greens.

Athletic Greens is a vitamin, mineral, probiotic, and adaptogen drink designed to help you meet all of your foundational nutritional needs. I've been taking Athletic Greens daily since 2012, so I'm delighted that they're a sponsor of this 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 meet all of my foundational nutritional needs. That is, it covers my vitamins, my minerals, and the probiotics are especially important to me. Athletic Greens also contains adaptogens, which are critical for recovering from stress, from exercise, from work, or just general life. If you'd like to try Athletic Greens, you can go to [Athleticgreens.com](https://athleticgreens.com) Huberman to claim a special offer. They'll give you five free travel packs and they'll give you a year supply of vitamin D, three K, two. Again, if you'd like to try Athletic Greens, go to [Athleticgreens.com](https://athleticgreens.com) Huberman to claim the special offer. What are a few of the major changes that occur in muscle, nerve, et cetera, when we experience hypertrophy? I've heard of protein synthesis changes. I'm assuming that's true. Maybe you can tell us a bit more about that. Changes in blood flow, perhaps? Changes in neural innervation. Who knows? Maybe even changes in fascia. I'm not aware of any specifically, but I have to imagine that they're somehow involved. Sure. So when we talk about hypertrophy, a lot of the adaptations are going to be similar because the mode of training is close enough, so your nerves probably aren't smart enough to differentiate between a set of five reps or a set of eight repetitions. They're smart enough to differentiate anything, like they know everything that's going on, but it's going to be a huge overlap. The primary difference with hypertrophy is a couple of things. So if you think about the muscle microstructure, I have a whole series of videos on YouTube, if you want to see the visuals behind this. In fact, in there, I include the specific diameter, size of muscle fibers that I failed to give you a few minutes ago. We will provide an active link to this. Great. So what happens is this. When we talk about and you hear this classic buzz phrase of muscle protein synthesis, generally what we're talking about there is contractile units. And so when we say contractile units, we're talking about the myosin and actin. And so what we're really trying to do is say, okay, there's some amount of protein turnover where we're coming in and we're trying to add more proteins to the equation. And so what has to happen there is a series of steps. So step number one is there has to be some sort of signal from the external world. This could actually oftentimes it's things like stretching of the cell wall, which is what happens with exercise. Right. So you're contracting a shortening, you get this big stretch of the cell wall. It can come from simple things like an amino acid infusion. This is just eating protein. This is why protein ingestion alone is anabolic. Right. It will help you grow muscle independent of even moving. Just eating protein will grow your muscles. Yeah, certainly. And those data are very clear. Of course, like anything, there's a saturation point in terms of total amount you need to get to and things like that. But, yeah, if you were to walk into a laboratory fasted overnight and I gave you 30 grams of protein, we would see a very measurable increase in protein synthesis quite clearly for several hours, probably four to five plus hours. We could maybe bring in some people that would know those data better. But many hours with no weight training. Correct. I am betting that most people are not aware of that fact. You know, what's actually interesting about it is if you do the exact same study again and you just did strength training, you would also see an improvement in protein synthesis. Right. But those factors are independent and the mechanisms are independent, such that if you do them both together, they stack on top of each other, which is really wonderful. And if you were to add carbohydrate into that mix, now you're actually adding fuel for the entire muscle protein synthesis process. And now you're going to see even additive benefits. And this is why for so many years. This is what bore the whole post exercise anabolic window thing, which is like you got to get carbs and protein in post exercise to maximize muscle hypertrophy. Now, that turned out to be not totally true in terms of the window. Window not be as strict as people initially asserted, as I recall. Still, I think that's super interesting. These are parallel pathways for protein synthesis. Simply eating protein or training each

independently increases protein synthesis. I can't help but ask, is the same true if one does endurance type exercise? If I go out for a 45 minutes jog where I can nasal breathe the whole time, but if I were to go any faster, I would have

to kick over into mouth breathing as well. So called zone two ish cardio. Will I see an increase in protein synthesis simply as a consequence of that? Jog? No, this is one of the unique factors of strength training. You're not going to see that, in fact, it's difficult to measure protein breakdown. That's been as extraordinarily challenging to do in the laboratory, but you're not going to see those benefits. In fact, you're going to see quite the opposite. It's an entire molecular cascade. So this is kind of how it works. So you have to have some similar signal on the outside and this can be an energetic signal. So this could be glucose uptake, it could be protein intake, it could be a physical stretch. What happens is on the cell wall, there is some sort of it could be testosterone, right? Testosterone could bind to beta adrenergic receptors and this activates a whole series of cascades of signaling proteins. And these proteins basically play a game of telephone. So one tells the next one, they tells the next one, and they sort of walk this entire way. Well, that molecular cascade is fundamentally the same thing, regardless of the insult. But they're different pathways. And so the pathway from strength training or protein ingestion is going to go to the same nucleus. It's going to activate a whole set of gene cascades that are going to tell you to go through this entire process of protein synthesis, which I'll walk through what that is in a second. If you do endurance training, it's a different pathway. And so instead of activating this entire thing of like mTOR and AKT and this anabolic signaling cascade, it's going to do a different one, which you can think of more of like as AMPK, an energy signaling thing. So there's a crossover point here. In fact, one of the things you'll notice is mTOR and AKT don't really influence AMPK. But there is some literature that years ago showed AMPK will activate another protein called TSC Two and that will actually inhibit mTOR. And that was the first molecular explanation for the quote unquote interference effect of endurance training on hypertrophy. Could you just highlight for people what this is? Because as you describe these signaling pathways. I just want to maybe just put a top contour explanation. The mTOR pathway is synonymous with cell growth, both during development as organisms, humans included, mature and cells get larger. mTOR is abundant in the system, to put it quite simply. And then the AMPK pathway and some of the metabolic signaling that you're referring to is more synonymous with cardiovascular exercise, at least in the context of this discussion, and fuel utilization and what you described as a crossover point where certain forms of exercise can tap into both of these. But at least for sake of this conversation, we're largely separating them. Yeah, because the byproduct is the thing that matters here. So the result of mTOR and AKT getting into the nucleus is going to be increase in protein synthesis. The result of AMPK running down to the is going to be result in increasing mitochondrial biogenesis. So the net outcome is different. Now, I do want to flag it very quickly. This is an extraordinarily complicated thing. And in fact, in our laboratory, we were able to be one of the first that figured out how to measure all the different subunits of AMPK and individual muscles by fiber. Because you're ripping people's muscles out of their knees and their patellar tendons just teasing, they're gently removing under IRB protocol, of course. So even when we say something like AMPK, it's not one thing. And when we say things like mTOR, it's not one thing either. You have the total amount that matters. You have the activation, the activation sites are many of them. So it's not as simple as what I'm laying it out. I just want to get a big concept of kind of what's happening here to actually kind of answer your question, which is, okay, so how is the muscle actually growing? What you have to understand is a little bit of how protein synthesis occurs. So what I'm generally meaning is you have a whole bunch of amino acids. And this actually goes back to maybe like middle school biology class, right? So if you take a bunch of amino acids and you combine them together, we get these things called a peptide, right? And if anyone who's never heard of like peptides, that's all it really means. You put a bunch of those together, you have a polypeptide, you put a bunch of those together, and we now have a protein. So any protein I want to make is going to go through the exact same system, the exact same steps. It doesn't matter if that protein is going to be a red blood cell. It doesn't matter if that's going to be a hair follicle. It doesn't matter if it's going to be skeletal muscle. That's basically protein synthesis. So when we tend to think of protein synthesis, we just paint this picture of growing more muscle. And that's not the only thing. And so when we talk about the benefits of having high

quality muscle as being this place that's going to regulate most of your protein synthesis. We tend to lose some people because they're thinking, oh, I don't need to gain muscle. And that's not what we're talking about. We're talking about regulating the immune system. We're talking about regulating any protein turnover. So any protein that's degraded or needs to be broken down in your system at all autophagy, this is such an important buzzword. That's just protein breakdown of an unneeded or damaged protein, right? That whole thing is going to go through protein synthesis to be able to come back and replace the things. The only reason you go through autophagy is so you can clean that garbage out and then come back and build in a more properly functioning protein. So it's not just about growing more muscle mass. It's why you want these systems to be operating well. So the protein ingestion is going to just activate that cascade because it's basically saying, oh, hey, look, we have an abundance of supply here, why don't we make something out of it? Because we don't know the next time this thing is going to be around. Carbohydrates and fat are very easy to store. Protein is very challenging. It's more transient. And so you can store some of it and keep it around, but most of it you're going to lose. And so when it's available, your body wants to act very quickly. It doesn't necessarily care if you have extra fat floating around in your system. It's all right, let's just package it up and store it. We can easily bring this back out. But if you got protein around, you're going to want to use it. And so that's why it alone will activate and increase protein synthesis independent of exercise. So those effects are additive, like I said, because that signaling process is independent. And once you hit a rate limiting phase, then you are there. But at its onset, those things will work independently. Okay? So that being said, what is skeletal muscle hypertrophy in general? We think about it as this increase in contractile proteins, those myosin and actin effectively get thicker. Now, what happens is, since they are thicker and as I talked about a second ago, that influences and actually hurts the lattice spacing. And so what your body does as a result is say, hey, let's increase the diameter of the entire cell so that we can maintain our spacing between these things, right? It's effectively like if the two of us were sitting in this room and you doubled in size and I was like, whoa, you're in my personal space and I doubled in size. Now we're in each other's space. At some point we just have to make the room larger. And that's exactly what's happening in the cell. And so as you can continue to increase muscle size, myofibular accretion, you're going to continue to increase muscle fiber size. For years, there was this other. Comment about non functional hypertrophy and this is often called sarcoplasmic hypertrophy. Now, this is not sarcoplasmic reticulum. This is the fancy way of saying my muscle is larger but it has no function. And the question would be, well, how the hell is that possible if I have more contractile units and I can make more of these cross bridges, perform more of these power strokes, this is what these contractions are called. How could I possibly be losing function? Well, that was bro science for a very, very long time. In fact, what it really came down to was are there different types of hypertrophy training? Some that induce contractile protein hypertrophy and some that induce sarcoplasmic hypertrophy and that was significantly challenged until recently. Mike Roberts at Auburn did a series of wonderful studies that showed quite clearly that Sarcoplasmic hypertrophy is probably happening. And in fact, there's probably a pretty easy explanation. In general, what happens is it is an increase in fluid in the muscle fiber and so this would allow for the diameter to be larger. But since there is no addition of contractile units, no more force production happens. And so he actually has a wonderful review paper, I believe it's open access, where you can go look and he created a wonderful graph, I think that's in my hypertrophy videos on YouTube as well. And you can actually see that it's likely happening in phasic changes throughout your training experience. So at the beginning of your training, but as the years and year or weeks rather months and then eventually years go by in your training, we have a change in the hypertrophy that's coming from contractile units versus Sarcoplasmic. So I think that it's an important note because again, people

are wondering like well, how the hell is it even possible for me to get larger muscle and somehow I'm not stronger? Well, if it came from simply fluid retention and this is not bloating, there's no negative really to this. It is simply holding of more hydration in the cell. The ammo gets larger and then

everything works that way. What you just described calls to mind something similar in the nervous system, which is neuroplasticity, which of course is the nervous system's ability to change in response to learning and experience and damage for that matter. And we think about it as one term, but there are many different forms of neuroplasticity. A discussion that we don't need to get into now, but there's spike timing dependent plasticity and LTP and long term depression which has nothing to do with psychological depression and on and on and impaired pulse facilitation and on and on and on and on and short term plasticity. What I'm starting to understand is that there are many paths to what we call strength increase and there are many paths to what we think of as hypertrophy. Many of these are going to operate in parallel. It's going to be rare that any one of them is going to be active alone in order to create hypertrophy or strength changes. And that certain forms of exercise and certain ways of doing exercises in terms of sets and repetition schemes and rest intervals between sets and between training sessions are going to tap into different mechanisms, but also overlapping sets of mechanisms. Which is why, if I understand correctly, you mentioned at the beginning that often, not always, but often, strength increases are associated with some hypertrophy changes and hypertrophy increases are often not always associated with strength increases. Do I have that right? Correct. And the beauty of this whole thing is while we don't yet know the mechanisms specifically and there's a lot of confusion and there's a lot of changes that happen, we actually just submitted a paper a few days ago myself, Jimmy Bagley at San Francisco, and Kevin Muurek has a wonderful muscle physiology lab at Arkansas. And this is a very lay article, actually, it's incredibly easy to read. We describe the role of myonucleation in muscle hypertrophy and this is actually a lot of interesting stuff we get into there, but we're learning more and more about it. As a quick example, so skeletal muscle is unique in the fact that it is so large in diameter. It's also unique in the fact that it's multinucleated. What that means is typically in biology, you see like a cell has one nucleus, that's the place that houses and holds the DNA and it's a control center. It tells it to grow, shrink, die, repair, that whole thing. Well, skeletal muscle in human is awesome because it has thousands, if not more, this nuclei, which gives it that plasticity. And so a normal cell has one place it has to go to for any time it wants to upregulate, down, regulate, do whatever. The thing is, your muscle fibers have these little control centers all throughout them. And for years we were like, okay, great. The amount of hypertrophy that you can experience is probably limited by the amount of nuclei you have because you're not going to exceed a certain size of muscle fiber if that's going to mean you lose control. And so we're like, okay, great. We found and identified a limiting factor to what will determine how much a muscle can actually grow. And then the next question was then where are these things coming from? And this is where satellite cells came in. And so it was very clear a satellite cell that's lying dormant sort of on the outside, the periphery of the fiber, will then go in into the fiber, it will turn into myonuclei, and then it can actually increase your diameter like that. And so then actually it was like, hey, hey, you're actually limited by the amount of these satellite cells that you can get in and turn into nuclei. And then the evidence came out that showed, hey, what if you detrain? So what if I used to lift weights like a long time ago and I got big, but now I've lost a lot of my muscle. If I train again, you actually get that muscle back faster than it took you the very first time to build it. That's what we call muscle memory like in our field. Now, on your side of the equation, muscle memory is something different, right? It's a nerve. Well, when people talk about muscle memory, like the ability to ride a bicycle after so many years of not having tried to ride one that's actually largely independent of the muscle, has something to do with the muscle, it's basically a nervous system phenomenon. 100%. So muscle memory has been co-opted by different communities to mean different things. On our side, muscle memory is going to mean that ability to remember that muscle size, right, that hypertrophy. Because as you explained, the motor control thing is a totally a nerve thing. I'll give you this one the nerve. People can have this one. Well, it seems to me that there are a tremendous number of parallels between strength and hypertrophy changes and neuroplasticity. This is coming up again and again in this conversation because we know, for instance, that if you are exposed to a couple of different languages early on in life, you will learn any number of different

languages far more easily later in life, of course. And that's because there's some crossover between different languages, especially Latin based languages, that allows for that. There's a substrate for it. It's similar to the ability to hop on a bicycle again phenomenon or play an instrument phenomenon, but it's broader than that. And again, I think this speaks to the huge number of different adaptive changes that are occurring in the cells and in the nerves that innervate these cells when one experiences increases in strength and hypertrophy. So to round that out and to go back to what I was saying there, what we're actually learning now is that nucleation thing. And by the way, this entire trajectory story is probably over the last like eight years, this is how fast we've changed our understanding of how muscle grows. The Sarcoplasmic Reticulum thing five years ago was bro science. Now it's pretty well established. The myonucleation thing was eight to ten years ago. It's changing every week. This paper we just submitted this week showed actually, while we had generally thought a few years ago, and in fact, you can find me on podcasts and probably in some of my videos talking about this and I'm going to tell you right now those things are wrong. Like we've just had new things come out in these last couple of years where that detraining effect we thought was a reason of, well, what happens is if you had the muscle before and you brought in these nuclei and they differentiated and turned into a nuclei and then the muscle got small again, you've preserved those nuclei. And that's why when you go to train again, they were already around. So the muscle grows faster the second time than it did the first time. Well, now it looks like that's actually not the case. In fact, it's actually probably what's happening is it's an epigenetic change in the nuclei's ability to access the DNA needed to grow muscle. It's effectively the analogy we used. The nuclei are remembering how to ride a bike. So it's quite funny that you said that, because it's not really necessarily that they're being preserved over time, they have learned the sequence it takes to grow the protein there, and it happens faster the second time. And we've also learned that there are specific nuclei. We've known this for actually a while. We found this in our lab. We didn't discover it. We saw this in our sum of our hybrids. But there are different shapes of the nuclei. Some are more oval, some are more elongated, and the shape determines a lot of the function. Some of them are hanging out more towards the periphery, and some of them are hanging out right around the nucleus. Well, it looks like there's actually probably different types of nuclei, a lot of them that are specific to the mitochondria. In fact, you can see on some of the imaging we have, they're just packed around the mitochondria. And there are some that are probably specific to injury repair. And so this is probably explaining a lot of the individual variation. I mean, I know you've said previously you're very slow at recovering. There's a lot of things that go into that. And I would love to walk through sort of all the buckets, maybe later into recovery. But one of the inherent genetic variations could be simply that you maybe have more or less of the nuclei responsible for tissue repair. That's something that's been happening in the last handful of months that's been coming out. We'll see if that holds up is true or not. So, as we're learning more and more almost every day about muscle physiology, what's super fun and interesting, and I think the most exciting what to do in terms of how to train and how to eat and how to do everything else to get these adaptations has been pretty well established for a long, long, long time. We're just figuring out what's happening in the muscle now, but we know what to do. So, from a practical standpoint, putting together protocols for any outcome that you want or don't want for any modality. You don't have a gym, you have weights. You have dumbbells. Only you only have kettlebells. You don't want to you only use body weight. You only have three days a week. You have seven days a week. You want to maximize muscle growth. You want to get a little bit stronger. Any of these variables you want to throw at me, we have a large evidence base for exactly how to get those adaptations and not others. So while we have a lot to learn about the mechanisms and the physiology. We have pretty good legs to stand on terms of what to do to get whatever adaptations you want. So

what are the essential components of an effective strength and hypertrophy protocol? Okay, so what I would like to actually do is walk you through both of those because as we mentioned before they overlap but the training needs to be differentiated so that you can optimize either strength, hypertrophy or if you actually want, you can get a combination of both. This allows you to then get

the adaptation you want, avoid ones you don't want and then get it even a combination if that's the preference. So a lot of people will talk about I want to get a little stronger, I want to add some muscle. That's a different answer than someone who wants to truly maximize muscle which is a different answer from somebody who wants to maximize strength which is a different answer from somebody who wants to maximize strength but not actually gain muscle. So we have all these combinations. What's important to understand before we get into the details is a couple of things. Number one, we've been teasing this concept so far of the concepts are few but the methods are many. And so I want to hit those concepts right now. As you say, these are the non negotiables that have to happen in any training program and I'm referring to these in the strength and hypertrophy conversation but these are true of power development, speed development, muscular endurance, endurance, any other thing. These are things that just have to happen for any training program to work. I mentioned one a little bit earlier which was adherence. And so my frequent collaborator Dan Garner will constantly say consistency beats intensity. Again, in fact literature will show you very clearly adherence is the number one predictor of physical fitness outcomes. So we want to do something that you will engage in, you'll put effort into and you'll be able to repeat consistently over time. So that's number one. The second one is and this is a major reason that people don't hit their fitness goals. In fact, I would argue outside of not doing it the number one mistake they make is progressive overload. So I'm going to walk you through exactly how much you should be increasing your sets and reps and weight, et cetera per week, per month later. But that's the biggest thing. You have got to have some sort of overload. The body works as an adaptation mechanism, right? So in fact we talked previously about the Harvard Fatigue Lab and one of the things actually people don't realize is the concept of homeostasis actually comes from research at the Harvard Fatigue Lab. It was work that they did on an endurance runner, I forget his name and they sort of realized that after a long period of time working out. This is an acute exercise spout the body actually comes back to some stable place despite the fact he was continuing to work. And that's exactly what bore the phrase steady state. And that actually then they launched off and they said, wow, there's this state that the body wants to be in and we'll call this homeostasis. So those all concepts came out of exercise physiology, which is really, really cool, right? We don't get a lot of love a lot of times scientifically, but that's a good one that we took. So why that? All matters is we have got to achieve some sort of overload without going excess. So we'll cover that later of exactly what to do and we'll potentially get into overtraining and monitoring and things like that. But you have to have some sort of consistent, predictable overload. That's what's going to cause adaptation to continue to cause stress. If you don't do that, you can still do things like burn calories, you can still get some of the other benefits of exercise like improved mood, cognitive function, et cetera, et cetera. Flexibility increases. All those can happen without a progressive overload. But if you want to see these gains in strength and hypertrophy, you really need to progressively overload. So that's concept number two. The third one here is going to be individualization and this is where we can get into things like personal preference, equipment availability. You have kettlebells or dumbbells or you only have bands or you have none of that. These are all smaller details, but that's an important component to it. The last one I really want to get into is picking the appropriate target. And we went through this when we talked about the fitness protocol. And if you run through something like that and you run some testing and figure out where your biggest limitations are, that's going to help you identify where you need to go. So if you can do all those things, you're going to be in a good spot to balance specificity and variation. All right? So if you want to make sure you grow your biceps, you better make sure your biceps are working. Having said that, if you over rely on specificity, you're going to increase the likelihood of overuse injuries, which is going to come back and actually hamper consistency over time. All right, so this is when hedging towards specificity is important, but too much can cause a problem if you go the other direction and you go too much variation. So imagine you're just sort of doing all kinds of different exercises every time you workout. That's actually not enough stimuli directly on the muscle or muscle groups or movement pattern if you're wanting to learn a new movement to get you very far. And so

this is a classic problem of I'm doing a lot of work, but I don't have a very clear direction. I lack specificity, so I'm working, but I'm not seeing a lot of improvements. And this is like in the business world, et cetera. This is like doing a whole bunch of different things means you get nothing really done. So that's the game we're going to play here, right? How do we overload this stuff? How do we make sure we're balancing specificity and variation? How do we make sure I want to do this? And then how do I individualize it for my needs and circumstances and movement restrictions and of time availability and my calendar and desires and all these things? So those are the concepts we absolutely have to hit. The methods that we choose run across a handful of variables and we call these things modifiable variables because as you modify them or you make different choices within these variables, you get different outcomes or adaptations. This is exactly what determines the nine adaptations that we've been talking about. So the way that I like to say this is exercises do not determine adaptation. So you can't simply go, I want to get stronger, therefore I'm going to choose these exercises. That's not how it works. What determines adaptation is the execution of the exercises. So deadlift is my favorite example. A deadlift is a common example that people think of when they want to choose a lower body strength exercise. But a deadlift will not increase your strength unless you're executing it in the proper fashion. I'm not only talking about technique here. I'm talking about these modifiable variables. The same thing for power exercises, we'll commonly see mistakes of doing activities like a box jump, which is great. People think, oh, I'm going to improve my power. Which we know is extremely highly correlated to activities of daily living and particularly living unassisted as you age, right, is reduction in power. So they'll do an activity like a box jump. What they're failing to realize is unless you do it powerfully, you won't actually increase power. If you don't move fast, you won't get faster. So the way that we manipulate these variables is everything to determining the adaptation you get or again, don't get. So with that foundation, I think we can kind of run right into these things and we can start off with perhaps speed and power. And what I would like to do is walk you through all those modifiable variables, what to do with them, and then hit you with as many different methodologies as we really have time for. And then we'll move on to strength and hypertrophy and kind of round the entire thing out. And then maybe at the end we can talk some other variables, like what happens if I have a training protocol and I'm halfway through it and I can't finish my workout? What should I do? Reduce my weight or reduce my duration or things like that. So there's lots of what if scenarios that we can go through that potentially a lot of people listening have questions about. So sound like a plan? Sounds like a plan. I'd like to take a brief break to acknowledge our sponsor, 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 and well being can only be analyzed from a quality blood test. One issue with a lot of blood tests and DNA tests out there, however, is that you get information back about various levels of lipids and hormones and metabolic factors, et cetera, but you don't know what to do with that information. Inside Tracker makes knowing what to do with all that information exceedingly easy. They have a personalized platform that lets you see what your specific numbers are, of course, but then also what sorts of behavioral do's and don'ts, what sorts of nutritional changes, what sorts of supplementation would allow you to bring those levels into the ranges that are optimal for you. If you'd like to try Inside Tracker, you can visit [Insidetracker.com](https://insidetracker.com) Huberman to get 20% off any of Inside Tracker's plans. Again, that's [Insidetracker.com](https://insidetracker.com) Huberman to get 20% off. So just to interrupt briefly and make sure that I and everybody else have in mind the proper nine adaptations that we've been referring to and that were discussed in detail in episode one, I have

listed number one, skill and technique. Number two, speed. Number three, power, which is speed times force. Number four, strength. Number five, hypertrophy. Number six, muscular endurance. Number seven, anaerobic capacity. Number eight, maximal aerobic capacity. And number nine, long duration steady state exercise. Yes, you nailed it. Thank you for that. It was probably important clarification

for everybody. So that being said, let's jump right into speed and power. Now, I'll do these a little bit simultaneously. They are different. If you're a high performance athlete, you really need to separate these two things. For the most people, though we can probably think about them as the same thing. There's not a lot of pure speed training that the general public is interested in. If you want to actually further break down speed, there are multiple components. There's acceleration, there's top end velocity, there's change of direction or agility and things like that. So we'll just kind of call all that speed and power for now. Now, at the onset there's this three to five concept that we talked about many times where this is really fairly true for speed, power or strength. Now, I didn't develop the three to five. It's just an easy way to help you remember one concept that will run true across all these things. So three to five refers to three to five days per week. Pick three to five exercises and you're going to do three to five repetitions per set. You'll do three to five sets and you'll rest three to five minutes between each set. If you do that and you execute any of the exercises that you choose at a high intent, and that part is critical, you don't get faster by moving kind of fast. You can't improve power by moving like powerfully. You have to be trying regardless of whether you're actually moving faster or not. Anytime you're talking about speed or power, you're by definition using submaximal weights, so you're going to be able to lift it. That's not the question. The question is how fast can you lift that implement? And so intention is incredibly important. So if you do that the same for strength, by the way. So if you land on that, that allows you to run the gamut from as little as three days a week. You're doing three exercises, you're going to do three sets of three, which is a very, very low volume, it's a very low amount of days, easy to handle, all the way to five sets of five of five exercises, five days a week. So again, it's just one sample. That's something easy to remember and is quite effective for a very long time. And this has been tested quite extensively in both the coaching realms as well as the scientific realms to be quite productive and easy to follow and grasp. If you do that, all you need to do is slightly increase the load or the volume, but mostly the load over time. And the number we want to look for there is something like a three to 5% increase per week. So an example would be if you're going to do an exercise at 100 pounds, you can't necessarily just add five pounds every week. That's going to catch up to you pretty quickly. And so you may have to run a smaller increment. If you're doing like a lower body exercise where you might have a couple of hundred pounds on the weight, you can probably get away with adding five pounds because it's still a low percentage of the total load. So that's roughly the guide that we want to get to for speed, power and strength. So that sounds incredibly simple and effective, yet I have a number of questions. Sure. First off, if somebody is using the three to five approach, does that mean they should not be doing any other weight training of any kind in those workouts or at all? No, you can certainly do that in combination with anything else you would like, especially if you think about speed and power. Those are very non fatiguing. And so if you could imagine, you're going to go to the beach and you're going to take a ten pound to 20 pound medicine ball with you, and you're going to do four different exercises where you're throwing the medicine ball as high as you can in the air, four times in a row, taking a break. And you do two or three sets of that, and you do maybe three or four different types of throws, those that's very good for improving power, extremely good, but it's not very fatiguing. So you could certainly finish that workout in 20 minutes and then run on and then do any number of other things. So you could do some high intensity anaerobic capacity work, you could do steady state stuff, you could even do hypertrophy on top of that. So there's two major categories of what we call periodization. There's many, many of them, but the two that have the most scientific literature are what's called linear periodization and another is called undulating, or often daily undulating periodization. And I'm flagging these two again, despite the fact there are many, many, many more because they represent two different concepts, what you actually just touched upon. So linear periodization is a hallmark by basically saying we're going to train one adaptation at a time. So imagine going say, six to eight weeks and you're only doing strength, or you're only doing hypertrophy or endurance for that matter. So in that particular case, you would not do anything else in combination. If you contrast that to undulating periodization, you would actually be doing multiple different styles

of training either within the same day or just different days. So it could be Monday is power, Wednesday is strength, Friday is hypertrophy, whatever, or it could be a little bit of strength every single day, a little bit hypertrophy every day, a little bit of power every day, and you would just change the amount of each that you do within the day to alter the emphasis. All right, now if you look at the studies, and there have been many RCTs on this, the result of both of these training programs is generally basically the same thing. They are equally effective. Here's the major difference though. One, if your goal is very specific to one outcome, you want to hedge towards specificity. So if you're like, hey, I'm trying to maximize the amount of muscle I can build in the next eight weeks, then anything else besides that is just distraction and potential interference. Does it really matter or not? Doesn't matter, but it's not helping anything else. So linear periodization is fundamental at providing focus and therefore the adaptations tend to be oftentimes larger in that specific area. The downside is you now go six to eight to ten weeks of doing nothing else, and so you are losing those other adaptations at a faster rate. And you can imagine doing something like speed work, only again, speed work by definition is non fatiguing. So when oftentimes we think of speed work, it's like, oh, I did ladder drills and I did all these things and I threw up at the end. That's not speed work. You just did a different type of endurance training, which is great and important. So true speed work is very high rest, very low fatigue, and actually, truly trying to reach a new level of. Speed or velocity. So non fatiguing, if you did that exclusively for ten weeks, you would be pretty unfit by the end of it because you would also lose a decent amount of muscle mass. Not because there's an interference effect, but simply because of the fact you have not stimulated muscle growth for eight to ten weeks. And so neither one of these is better than the other. We're going to see this classically across all program design or periodization strategies. Is it's a give and take? There are tons of different systems and perhaps at the end we can talk about some of the more advanced periodization styles. These ones are both effective. You could do these with beginners, you could do these with advanced athletes, you could do them any spectrum, but they're some of the more well documented ones. It's just a pro and con game, right? It's what are you willing to give up? The way that you solve that problem is going back to that fitness assessment and your analysis and really truly understanding what your goal is. Is your goal to do a little bit of strength and a little bit okay, great. Maybe undulated periodization is an approach if your goal is really to maximize strength and maybe you can wait on putting some muscle mass on, maybe linear periodization is a better approach or another style of periodization that's optimal for strength gain. So it's just simply about addressing your things. One of the major problems folks have, in addition to lacking progressive overload is they don't have any foresight past the next day of the training. And so it's really important that you set off blocks that are anywhere between six to twelve weeks long where you're going to have the specific plan. Ideally you have an idea for the whole year. I actually have like a structure I could walk you through for that. But even if you don't have that, really think about what you want the next twelve weeks and then maybe the next twelve weeks after that. And that's going to give you a lot of guidance about what to do and what to focus on. Terrific. What about warming up? I was taught that one should do higher repetition movements with lighter weights in order to warm up. And then one of the things that did make a big positive difference for me in terms of strength and hypertrophy training was to do a moderate repetition warm up with a fairly lightweight but then to actually keep the number of warm up repetitions fairly low and work progressively toward the first so called work set. When you say three to five, that's three to five work sets, correct? Yes. Are you also going to tell me three to five warm ups? No. Are you also going to tell me it has to be done between three and 05:00? P.m.. So in terms of what, three to five friends? In all seriousness, what does a good warm up look like. And I realize this will vary depending on how cool your training environment is, time of day, et cetera, but as a kind of umbrella for a good warm up, okay, what should people do? You've already sort of jumped the gun with my answer. It is honestly very dependent upon the person. So some folks respond very well to a minimum warm up. Others I've had lots of actually, professional fighters I've worked with where I actually have a Major League Baseball player right now. He's one of the best pitchers in the game,

probably the best. And the longer we warm up, the better his numbers get. We actually did a vertical jump test with him. He's going to kill me because he got so mad. I wanted to see how long it sort of took him to reach a peak vertical jump. And most times this takes people something like five to ten sort of reps. And I said, take it up all the way to a maximum vertical jump. And then what I want you to do is continue to jumping until you have three consecutive jumps or you're down lower than 90%. And so what we're trying to look at is sort of when is he going to break? Because in baseball, he's going to throw like 100 pitchers or so. And we're trying to figure out when is his peak velocity on his fastball going to drop and sort of base his conditioning on that. It's a different style of conditioning. It's power endurance is really what it is. He called me in the middle of it, and I'm like, oh, he done whatever. And he's just like, no, how many of these am I supposed to do? And I was like, what are you talking about? He's like, I'm on rep 130 or something. And I was like, what? And I'm like, what rep did you peak on? He peaked on rep 70, something like that. 69, I think technically because he's goofy. So he's a classic example. I've worked with him for many, many years. We have a ton of data on him, a ton of biological data, a ton of neuromuscular stuff, like all kinds of stuff. And it's just the more he warms up, an absurd amount of warm up, the better he gets. And the better he gets in power production and the better he gets in speed and velocity. So his warm up prior to games is totally absurd and just the more volume we throw at him, the better he does. I have other folks, you get past like two or three reps and fatigue starts to set in, and now you're actually like reducing power production. So there is a ton of variation that goes into that. I can give you some guidelines, though. You need to differentiate if you're training for speed, power, strength, or hypertrophy. Here's why. If we understand a little bit about what's causing the adaptation that's going to tell you what you need to do or avoid. For example, volume is the primary driver in hypertrophy. Intensity is the primary driver in speed, power and strength. What that means is you need to preserve intensity for the first three. You need to preserve volume in the second one at most. So if your warm up is so extensive in the hypertrophy training that it compromises your training volume because of fatigue, even if it compromises the last set of the last exercise, then you're actually probably walking yourself backwards. By doing that extensive, you would have been better off starting your first working set slightly suboptimal, right? Because you're just trying to accrue volume at that point. Strength and power is the opposite. Until you're moving very, very fast or powerfully, you're not really causing the adaptation. So there's no point of starting your working set until you're really basically at 100%. So the warm up should be as long as it takes you to get to where your mobility is in the right spot. Like your joints feel good, you feel fresh, you feel activated, and you really feel peak power. Anything before that is a warm up set. In the sport of Olympic weightlifting, a lot of times the coaches will measure barbell velocity. Travis Mash has done a fantastic job with this. He's got a lot of data on what's called velocity based training. Brian Mann at Missouri and Miami, tons of work here, and generally those communities are not going to count any repetition as a working set until you exceed 70% of your one rep max. Where that's changed because of a lot of people doing the velocity based stuff is now they're basing that simply on an achieved velocity. And so really, the warm up is irrelevant. It's sort of just like, do whatever you want and we're going to measure the barbell until you actually hit an outcome. And now you're at we're a working set. So different ways to think about it, depending on what you're training for, that'll give you a little bit of a guideline. If you're training for anything past hypertrophy, then really, and especially even hypertrophy, it just comes down to, are you feeling ready to work? Are you cold? Are you moving through the correct positions? And if all those things are fine, I don't care if you start a little bit early and save some gas, especially if you're a person like you who may be a bit more inclined to fatigue quickly relative to Trevor, who just has no response to fatigue whatsoever. Is it useful to do more warm up at the beginning of a workout, say before the first exercise, and then once one has achieved both local and systemic warm up in air quotes, then perhaps on the second or third exercise, fourth exercise, et cetera, one or maybe even zero warm ups? Yeah, fair point. We generally think about warm ups in a couple of ways. This is a very clever question. You want to have some sort of general global warm up scheme. We tend

to prefer dynamic warm ups. So this is whole body movements rather than like sitting and stretching, static stretching, things like that. So something that involves momentum. Yeah, momentum or movement. Right. So this is like think about this in old gym class. It's like your high knees and your butt kickers and just different things like that where you're moving in different planes, you're moving joints through tons of range of motion. You're getting a lot of movement there. So you're getting the local warm up. You're also getting the total systemic activation. Everything else is going on there. So that is what will be considered to be a general warm up. Five minutes is a very sufficient number, perhaps ten if you're a slow goer achy and some things like that. And you really got to get the ankle warmed up. If you're doing lower body stuff, really make sure that's moving correctly, the hips and knees will follow. Upper body stuff, really get the shoulder blades and the neck like making sure you're going there and the elbows will follow after that. So five to seven minutes of a general warm up. A lot of the times like classic exercise science, it will even just put you on a bike cycling for five minutes. I don't like that personally. Dynamic movement is more preferred. If you really just move for five to seven minutes, you'll be fine there. Now specificity within each movement. It's very important that your first exercise of the day is generally the thing you prioritize. That's oftentimes the most important you're going to do for it oftentimes is also the most complex and the most moving parts. So it tends to be multi joint. Therefore you need to have movement precision and skill dialed, right? You don't typically start your workouts off with the forearm curl. You don't need a tremendous amount of warm up to get going on that. You're going to start off with medicine ball throws or a snatch or some agility work. You need to have the whole system going because multiple joints are moving, position matters, technique, there's just a lot of skill requirement, et cetera. So the individualized workout or the specific workout for the specific movement for that very first one, my general rule of thumb is like whatever it takes to move perfect in that first exercise. Past that, you don't necessarily need to do individualized warm ups for your next movements unless it is a movement you're trying to learn or just even get a little bit better at. Drop the load a little bit, work on some accruing, some practice reps. Fantastic. Or it's another dissimilar complex movement. So let's say your first exercise was a front squat and you got loaded for that and now you're going to move into a pull up. But your mechanics aren't the best there and so you really need to change and do some, maybe more specific activation warm ups for that or something else or it's running or something totally different. So yeah, you don't need to re warm up for every single exercise as you go. Generally, once you're good to go, the same muscles that you're going to use in the next exercise are warm, same joints, then you're good to go. You talked about intent within the movement. What about specific cadences for repetitions? I was taught that one should lower the weight slowly, the so called eccentric portion of the movement, and then to try and explode the weight through the concentric phase and then also make sure that one is using full range of motion and perfect form, as it were. Now of course, that is one tiny slice of the possible rep cadences and ways to approach resistance training, although I think it's a pretty good one. What are the general parameter sets that one needs to consider? You could imagine lifting 4 seconds, concentric, pause for one, pause for two, eccentric. I realize there's an infinite number of variations here, but is there a way to use rep cadence, repetition cadence that is, as a way to work through weak points and to be strong in every position of the movement? Yeah, a lovely question. I think the way I would like to answer this is maybe going back just a touch to get directly to that. So I think if we walk through power, strength and hypertrophy and I hit you with the concepts that are specific to each one, that's going to lay out your answer. Because the most

true answer there is, it depends on the goal. The answer for what is optimal for strength is diametrically opposed. For potentially what's optimized for hypertrophy, the same exact thing can be said for momentum. So we've classically heard things like this don't bounce at the bottom, you're cheating. So if you're doing a lap pull down or something, you don't bounce and rebound, you stop at the bottom, slow down. All these things are thought to be truisms of strength conditioning. But guess what? Those are all truisms, assuming we're trying to grow muscle. And that actually goes back to our conversation in episode one

about a lot of the things we think are just fundamental truths about strength training are just fundamental truths that came from the bodybuilding world. And they're not wrong, they're good ideas. But there are other adaptations one needs to get from strength training that are not just maximizing muscle growth. So what I will lay out to you is a case for which you should bounce, a case for when you should go fast, a case for when you should be under control. All these things are different variables we can modify and get different adaptations for it. Is there a way that you could lay out for us optimal repetition cadences for strength specifically versus hypertrophy specifically, just to sort of bookend the conversation and then migrate toward the middle in terms of rep cadences that would satisfy the desire to have a bit of both. We can get pretty close. Yeah. So when you're talking about strength versus hypertrophy, remember, strength is movement. Hypertrophy is muscle size. That's the key to your answer here. So when you're trying to get stronger, what you're effectively trying to do is get better at producing a certain amount of force through movement. Now, force is mass times acceleration. So what's the mass in the bar multiplied by how? Well, I can accelerate it intentionally? Going slower is only reducing acceleration, right? So it's hard to argue that going slower is going to improve strength because you're simply reducing acceleration. So you need to practice lifting heavier at a faster rate. Now, does that mean if you're trying to get stronger, there are no phases of your training in which you will slow down or pause? No, of course not. There are certain rules in different organizations where you have to pause the bottom of a lift like there's all kinds of little things like that. But in general, we want to think about what are we trying to do here? We're trying to get better at moving a heavier mass at a faster rate of acceleration that is more force, that is more strength. Hypertrophy is not that the goal here is not a functional outcome. It is what is needed to cause the most amount of hypertrophy. And when you get to hypertrophy, then your optimal cadence is up to you. You can do any combination. In fact, you could do it the same exact cadence that you did your strength training with and get the same adaptations as hypertrophy if you modify the other variables appropriately. Or you could go slower, or you could do pauses, or you could do a thing that is called triphasic training, where you spend the first phase, several weeks of your training where you do eccentrics only. So you're just lowering the bar and you're basically stopping. You could then do the next phase of your training, which isometrics, where you're just holding at that bottom position. And then the next phase of your training, you're focusing on the concentric portion of it, right? Triphasic, one, two, three, eccentric, isometric, concentric. So that's a fantastic way of developing, actually, strength, a little bit of hypertrophy, but you're manipulating the variables in terms of how you execute the repetition range. You can actually induce a lot of hypertrophy moving the weight fast, as you mentioned, even down slow into control. Now, one thing one will never advocate is moving any sort of weight or load uncontrolled. The assumption here when I'm saying go fast is you're always in control. I never want you bouncing and crushing your sternum with a barbell off your desk. But you can move at a lot of rates. The isometric I mentioned, because this is when things like body weight training come into play. Absolutely. You can gain strength and even a little bit of hypertrophy, especially in the upper body doing isometrics. It's much harder to do this with the lower body. You outrun that coverage really quickly. You need load. But there's a lot of ways this is also probably why people have done things like gone to yoga only or Pilates or some of these things that are body weight based and there's no external load and they've actually increased muscle size. So I'm getting the picture. There are a ton of options in terms of rep cadences. However, can we say that one should pick a given rep cadence within an exercise rather than changing it from set to set within an exercise? Or that one should perhaps even pick a certain rep cadence for an entire workout? I'm suspecting that your answer is going to be, it depends. Yeah, it is. But I'm not going to use if you had a gun to your head kind of situation. But if you had a gun to your head, what would be the rep cadence that you would prescribe for strictly strength or as much strength with as little hypertrophy as possible. And in picking that rep cadence, then it therefore has to thread throughout the entire exercise bout. So you're actually right, because of that undulating periodization stuff I talked about, you can actually do this in a lot of ways. So you could do one exercise at the beginning

where you have a set cadence, say a three one. One is like a very one. So that's lifting for three, pause for one, lower for one, generally the opposite. Okay? So the first number is always the eccentric, generally, okay. Depending on exercise, lowering the weight for a count of three, pause for one. It totally depends on the exercise. Like a deadlift starts concentric and finishes eccentric, but a bench press starts the opposite. Okay, so it's start to finish. Start to finish is the better way to think about it. Yeah, I'll clarify.

Actually, when we say three one one, we're generally talking about almost always the eccentric is the slower portion, regardless if it's the first or the last, right? So whether you're doing a bench press or the eccentric is lowering the bar to your chest. That's the first part of the movement. One, two, three, pause one one up, which means accelerate as hard as you can on the way up. That's what you describe, right? As opposed to, say a row. A row, which is actually going to be starting off concentric. So you're going to be pulling that thing to your chest as fast as you can under control, not slamming off your chest, holding for 1 second and then taking 3 seconds to lower it back on the rack or on the ground or whatever. So the reason we do that is somewhat intuitive, but it is, again, to make sure you're not advancing a bar or an implement onto your physical body at an extremely fast rate. That's very difficult to deal with. So a three one one is a very standard strength protocol. That is something you can just run with. If that's all you ever wanted to do, it'd be absolutely fine. Lower the bar for a count of three. It actually ends up being approximately three because super hardly anybody is counting off seconds. Precisely. I suppose it's doable, but then pausing briefly. Yes. And that pause is almost unmeasurable. It is simply, are you under control? Before you transition from the eccentric to concentric? Concentric, it's just a safety thing. So once you feel down, you've reached complete range of motion, you're ready to transition, then just go. You don't really need to go like thousand watt and then go up. It's just making sure, again, we don't slam weights off of body parts and that fine. Final one in the three one one is really as fast as the execution of the usually concentric portion of the exercise. Yes. As fast as you possibly can. Okay. So that would be for the majority of the outcome being strength. Yes. Okay. And of course, we should acknowledge again, there are a ton of variations that one could implement there, but that would be a good starting place on the opposite side. For somebody who's mainly interested in hypertrophy, what would be the rep cadence that if you had a gun to your head that you would prescribe? I would probably do the exact same thing, but I would make the last number two. So three one two. You could also just keep three one on. It is still very fine. Even exploding on the concentric is still highly effective for training hypertrophy. So if you wanted to keep it super simple and just make rep cadence not a variable that you play with because you have other ones to move, that's great. If you want to add a little bit of time to the concentric phase, fine. It's not going to make enough of a difference for most people for you to really worry about. I guess that's sort of the point I really want to make. This is a classic example of we're deep into a method, right. If as long as you hit the concepts I talked about earlier, whether you want to do 311-3233 triphase things, this is just a method choice. That doesn't mean they're irrelevant. There are subtle changes within them. It's just 80/20 rule, right. So 80% of the benefit is going to be from the concept. 20% is this small thing. If you're super into this field or you actually want to work with a qualified certified coach or something, there's lots of reasons to play with this. If you're just on your own here and running this thing, three one one is fine. Three one two, totally fine. Anything like that. You really just want to make sure that in the strength side of the equation, you're under control and you can add enough load to stimulate strength and not get hurt with an acute trauma.

Right on the hypertrophy side, you're just wanting to load enough to where you can hit volume because you got to put a lot on there. So if you want to go lighter, if you want to go slower, fine. If you go slower in your repetition so maybe even like a five second eccentric, a two second pause, a three second rise, that's great. You can actually then stimulate the same amount of hypertrophy and either do it with less weight or do it with less repetitions. So it's a variable you can play with if you're like, hey, I don't have enough weights at my house or I only have a kettlebell or a dumbbell. How am I going to stimulate hypertrophy? Your only option is really doing more reps. Well,

eventually that train runs pretty shallow. Okay, here's the thing you can play with. Maybe just add time under tension is what we're calling it, right? Just do slower repetitions, go longer ones and hold it. So it's a variable that we use to individualize programs rather than something that you should really be focused on as like a core aspect that's going to be driving whether or not your program works. It's just a tool we can play with in the what if scenarios. I will use this stuff a lot when I'm traveling. You can do a tremendous workout in your hotel room just doing like a ten second eccentric, a ten second hold, a ten centric concentric. Yeah, I've had some decent hotel room workouts. They're not my preference, but by simply doing things like ten second lowering handstand push up against the door, totally, obviously assisted for me. I can't do a free handstand push up. I just don't have the skill or the strength or both. You can do some sort of configured dips between the beds or chairs and this kind of thing. Rear FID elevated split squats are great to do in hotels. Put your back foot up on a bed and get an amazing split squat workout done. Yeah. Glute, bridges, lots of stuff you can do there. Yeah. And with a jump rope if you've ever heard someone jumping in the morning. Yeah, it may or may not have been me, it could be any number of things, but I'm known to skip rope in hotel rooms. Not to get overly detailed, but I think there are going to be a number of people wondering about how to breathe during repetitions and how to breathe in between sets. So I'd like to just briefly touch on this and this is something that I know we're going to return to again when we have our discussion about recovery. But is there a general rule of thumb for how to breathe during repetitions, during work? For strength, maybe even strength versus hypertrophy in a way that maximizes oxygen input to the system keeps you alert, conscious, but that also protects the body by creating some rigidity in the system. Right. Because certainly being with all your air exhaled, the body is a very different beast in terms of stability than with the body full of air versus breathing. During the repetition movement. There's a maneuver that has long been labeled the Valsalva technique. So what that really means is you're trying to use air to create intra abdominal pressure. And what you're really trying to do is create a cylinder around your spine. The real issue you have to play here is regulation of blood pressure and spinal stability. Now you should be able to breathe and brace. What I mean by that is you should be able to create total intra abdominal pressure, regulate spine control while breathing. It's just very hard for a lot of people to do. It's a skill you should absolutely work on. You can do this and you can go around like, I do this trick in class and students can come and push. Any part of my entire abdomen is super tight, and I can talk now. It's going to be a little bit labored. You can hear a little bit of a difference, but you should be able to do that if you have to hunch down and you can't even muster a breath and it takes that to create pressure there. You don't really understand the abdominal control necessary to create that stability. So step number one is that's the goal. Now with the blood pressure thing, we have to be careful because a standard blood pressure, ideally, if we sat around right now, it's probably something like 120 over 80 systolic versus diastolic, that's a normal number, right. High blood pressure is something over that. Well, with an acute bout of exercise, you can see that number reach as high as like 450 over 350, which effectively means you have total blood occlusion. Right. Your blood pressure is so high, blood is not moving anywhere. And so in the middle of a very heavy set, especially complex movements, especially when they're loaded on your body, this can be an overhead press or squat variations, anything like that. Blood pressure is going to be a problem. And the reason why that matters is that's what's going to make you pass out. It's not the fact that you ran out of oxygen in 3 seconds, it's the fact that blood pressure got so high you blacked out. And so we're going to have to play this game of releasing a little bit of the pressure so we can actually get blood to move a little bit, making sure that we don't lose spinal stability so we can finish our workout. That's really the question you asked, right? How do I play this game of, oh, I have several hundred pounds on my back or my chest, and I don't want to exhale so that I don't lose spinal stability. But at the same time, I don't want to pass out, which is a problem. So kind of a couple of rules of thumb. If you're going to be doing something in which you can complete the entire exercise without a breath and it is of a maximal or close to load, that's probably your best strategy. So in that particular case, you'll see a lot of breathing techniques

where you're going to take a very large inhale. Ideally, this is done through the abdomen, not the shoulders. So we shouldn't see clavicles rising during this thing. You'll see a common mistake of the bars on their back and you see people do this like, big inhale thing and all they do is elevate their clavicles. That's not necessarily going to increase pressure through the abdomens, which is what you're looking for. So you want to be thinking about belly moving out in all four areas in front of you, to your left and right and to your back. That's that quadrant sort of idea of stabilizing your spine. You can do that independent of your clavicles moving. Your shoulders don't need to rise for that. You don't really need the oxygen for metabolic purposes. You're just using the air for a brace. That's really all you're after. So you're trying to visualize your torso as more or less a cylinder and you're trying to fill it with air. The logic being that if I were to push down onto, say, a full unopened can of soda water for all you sugar folks out there, soda water, and then push as hard as I could, it's going to be hard for me to crush that can. But if the can were empty or if it were a little bit kinked in the middle correct. Then I could likely crush that can. Yeah. What you're really doing is you have your spinal erectors in the back, right, and then a whole series of abdominal exercises, and you actually have some neural control, systematic control of contracting those, but you don't have muscles on the inside that you can do. So you're basically bringing in air and saying, I'll use air to push from the inside out and I'll use muscles to push from the outside in to create this brace and I don't want over compression with the muscles. If you see people that have just enormous spinal erectors, sometimes that's an indicator of actually a poor breathing or bracing strategy because they're using spinal erectors to create all their compression and not actually using the inside enough. It's not always the case, but sort of like a thing to think about. So over compression through the spinal erectors is not necessarily ideal. The best scenario is a little bit of a brace of both. So we use some air to push this side, we use some musculature to press that way, and then that spine is just nicely held in position. Again, not no position where I've locked down my diaphragm and I can't get any air route, I should be able to get that braced pattern and then be able to speak. In fact, I'm doing it right now. And you'll see a little bit of a you if you're really paying attention to my voice, you can hear a little bit of a subtle difference. But I should be able to do this for quite a long time. I could take a maximum rep right here in this position, whether I'm overhead pressing, doing some sort of row like anything, and feel fairly braced in the entire quadrant. This is very helpful, I'm going to work on it. But can we say that an effective way to start off in terms of breathing during repetitions would be to take a gulp of air during the lowering phase, the eccentric phase, and then to exhale during the concentric exertion phase. I asked that because that's what I've been doing for a while and it makes me feel safe. I don't know if I am. And it allows me to exhale as I exert the hardest portion of the exercise. And perhaps I also borrowed that from martial arts where one tends most often is trained to exhale on the strike. Yeah, if you're going to be doing again, the number of repetitions can be completed without a breath. A lot of times you're better off saving that exhalation until you complete. Well, but you don't have to but for a reasonably heavy set of hack squats or even leg extensions. And given that I already can't leg extension my body weight, maybe this, maybe this is why the idea of holding my breath for an entire compound set. So again, I'm glad. Bring to mind where is my insurance card, who's going to drive me to the hospital, this kind of thing. In all seriousness, what if I want to breathe during the set? Yeah. So I'll clarify. I'm generally meaning if you're doing like a one rep max or something like that, okay, certainly

I could hold my breath for a one rep edition maximum, maybe like a double or something like that, depending on what you're doing, like maybe AAAA bench press, you can probably do three and get away with it. A squat, it gets harder deadlift. So it kind of depends on the exercise. You want to take that breath though prior to the eccentric portion, not during. So lower breathe in lock. We're set. And now start our movement pattern. Wherever it's going to be exhaling on the concentric portion during it, it is fine, it's no problem, especially if you're not extremely heavy. And what are your thoughts on grunting and screaming? Yeah, fine, I don't care. I don't tend to do that. I'm occasionally known to squeal or whimper that matches your personality. But I do

it very quietly. I think of you and I think squeal, whimper, absolutely. Thanks. If you're going to be doing multiple repetitions, what we actually do for the NFL Combine is we teach them a very specific exhale strategy. So there's one test that they do, which is they bench press 225 pounds for as many reps as possible. A lot of these people will get 25 to 40 repetitions. So we have a very specific breathing pattern. It would be something like if we think that they're going to do around 25 rep, say that's like our goal. We might say, okay, do the first ten without a breath and then exhale, reset, and then do five breath. And then you might do five breath, three breath, two breath, and then one breath per rep until we can't get any more. So we'll have very specific strategies for them. So what I would say is think about how many you're going to complete and then breathe according to that. And it tends to increase in frequency as the number gets closer to failure because you're going to want that air a little bit, but you just want to make sure that when you're breathing back in, you're in a safe spot. So you don't want to be catching that like rebreath when the weight's on you. You want to be in a locked out position or away from you or when you're standing. So it tends to be like at the end of the exercise, not in the middle of it, which is going to be a rest of your problems. If you take your breath, then one of the reasons I'm so happy to have you here having this discussion is we can really get into the weeds but also hit a number of questions that I hear a lot. How does one contend with the first attempt at a lift not working out? Is it too heavy? Something goes wrong? Hopefully not injury promoting wrong, but something goes wrong. Do you count that? Do you reset the workout? And then the counterpart to that question is what do you do if it's too easy? It went wrong because you didn't put enough weight on the bar, didn't pick up a heavy enough set of dumbbells. Do you abandon the set and replace it with another? I guess this is really a question of how much margin for error is there in volume when doing this three x five program. Sure. Two things that I like to start with. Number one is I talked about linear periodization and undulating periodization. There's actually a new model, newish model called Autoregulation which basically says you're going to go in today and depending on any number of biomarkers performance markers or your performance, you will adjust your training based on how you're feeling that day. And so 70% is maybe, for example, not necessarily 70% of your one repetition max, highest ever. It's 70% of what you can do that day. And so it actually allows you to auto regulate your training based on actually what's happening. And so you don't have to have as much long term planning in your program design because it'll sort of figure itself out as you're going. You can use velocity to determine this auto regulation. You can use actually, it's like taking it up to close to a max for the day and then basing all your percentages on that daily max or a lot of different ways. So that is actually one very effective strategy. And there's a lot of research coming out on autoregulation. There's a lot of different ways to do it. So that's one thing to say. Another thing to say is this three to five. Okay. It depends on if we're going for speed, power, or strength. Because while all those other variables are the same for three to five, the core difference between whether that is a power workout or a strength workout is the load, right? So if you are at a moderate load, say 30% of your one repetition max, up to about 70%, that's going to be a power based adaptation. Assuming you're going with high intent sorry, I have to interrupt. Maybe just clarify what intent is. Yeah, you're attempting to move the implement or go through the movement pattern as fast as you can. Great, thank you. If you're trying to go for strength and you're below 70%, you're not really going to be improving strength because the total mass is not heavy enough. And so really, when we say strength, we're assuming you're at at least generally 70% or higher. Now, if you're new to training, totally different thing, right? But if you're moderately trained to highly trained, you're going to be well north of 70%. So anything below that, we don't really count anyways. Those are warm up sets, basically. All right, so one thing to actually give you some very specific numbers here, and I don't have all of these memorized. We can perhaps provide a chart later or send out something to them. But there's a chart that you can look up called a prilipin chart. How do you spell that? P-R-I-L-I-P-I-N prilipin. And there's actually been a few studies on it. It's been around for a very long time. It's sort of in the coaching realm. And then a handful of studies out of New Zealand came out verifying and validating a lot of it. But what it effectively does is

if strength is the goal, and this comes from the powerlifting weightlifting sort of communities or optimizing for strength, then how much time do I need to spend at each intensity range? So 70%, 80%, 90%, et cetera. Because specificity is going to say this. If you want to get better neuromuscular guy at shooting a basketball, the most important thing you could ever do is shoot a basketball under the exact circumstances that you're going to do it, right. Specificity always wins. If you want to get better at strength, the most important thing you need to do is that exact movement at that load and in this case, if you wanted to get better at bench press, lifting at 100% of your max on a bench press is the most specific thing you could ever do. The more you can do that, the faster you will increase your bench press max. However, that's very hard to do without getting hurt. It's also not addressing what I call your defender. So if the reason you can't bench press higher than whatever you're benching now, it may not be your pure strength. It may be any number of things, like you don't have enough muscle or technique or things. Okay, great. So specificity over here, variation on the other side. And so we're playing this game we've talked about of how do I make sure that I can have enough specificity in my training without leading to overuse injury? How do I maximize or how do I reduce my chance of injury while getting enough specificity? And so we have a classic paradigm over here. One actually training protocol you can look up is called the Bulgarian method. And the Bulgarians were amazing at the sport of Olympic weightlifting. Probably, in fact, the patriarch of this entire thing recently passed away. Ibajev niam sula monoglu pocket hercule s. One of the greatest weightlifters of all time came out of the system, and they do a lot of things. But one example in the Bulgarian system is you're going to do a one repetition maximum snatch. You're going to take a little bit of a break. You'll do a one repetition maximum clean and jerk. Take a little bit of a break, do a one repetition maximum front squat, take a little bit of a break, and you're going to repeat that two to three times a day, every day. That's specificity, right? Those people get extraordinarily strong now. They don't do that all year round. They don't do that with all their lifters. But this is when we're trying to peak for a major competition like the Olympics. We are going so far into specificity, and that was very counter to the Russian system at the time, which is much more of our classic periodization sort of approach. Okay, specificity is tremendous, but in doing that, the Bulgarians just brutalize a lot of athletes, right. Because it's very difficult to handle something like that. And you can't really do that that long without getting wrecked there. The goal is to win medals. The goal is it's a totally different thing than longevity out of here, right? Like we're trying to push the boundaries of or aesthetic changes unless someone has a naturally balanced physique. In general, if people do one sort of movement, I find that they tend to resemble the equipment that they did that movement with over time. Right? That was a joke against kettlebells. Of course. I got it. So we know specificity is technically optimal, but it's not realistic, not for that kind of extreme situation. So how do we balance these things well, it turns out this Prillapin chart gives you guidelines for how much time, and by time I mean how many repetitions to stand in each of these rep ranges so that you get kind of the best of this world. You're going to find the same thing. By the way, when we get into endurance training, there's only so much training you can do at 95% of your heart rate before it starts becoming quite detrimental. You need to actually spend a lot of time at those lower intensities. So the Prillapin chart walks you through how many sets and it gives you a range. I think that the bottom of it is like, how much time do you spend at 60% to 70% of every one rep max. And it says like, minimum of this set to maximum of this set. But the ideal number of reps per set per week is like 18, and then it walks you through. And so there's four criteria on it. I think it's 55% to 65%. Again, how many reps there? It's like three to six reps per set, 18 to 30 reps total. And I think the ideal rep range is like 24, something like that. So it takes you 55 to 65, 70 to 80, 80 to 90. And the 90 plus percent, what you'll see is the 90 plus percent number is more like one to two reps per set for a total of about seven total repetitions. If you start cruising past that, other bad things start to creep up in there. So that's a really effective chart. What it really highlights, though, is even somebody who's trying to maximize strength, you're going to spend something like 35 or so percent of your training time between this, like 55% to 65% range. So you're asking earlier,

like, well, do I even count that one? The answer is yeah. In that range, if it's below 55, 60%, you probably don't count it. Now, again, some coaches don't count unless it's even above 70. Fine, it's not a major distinction, but you're going to spend the bulk of your time accumulating some technique, basically, and skill and tissue tolerance, very important. The next step up is like 28%, I think is sort of the cut off of how much time you spend between 70 and 80% of your one art max. And then it jumps down to like 23% and then all the way to 70%. So you can walk yourself through that and that gives you an extremely good guideline. And you'll notice all of these are still in the three to five range. It's just really you're manipulating it by total sets or total exercises so that can give you some structure to play with. We will provide a link to the Prilipin chart in the show. Note captions training to failure. When the goal is strength, should one do it, should one avoid it, or does it depend? Well, yeah, it always depends. The way that I'll generally say it is because of what we just outlined in the Brillapin chart, you don't have to go to failure to see strength gains, especially early or even moderate, and I'm talking maybe five plus years. In your lifting career, would you call beginner zero to five years of training, intermediate? Five to 20 years of training, yeah, something like that. And then advanced would be people that really put the time and energy into fine tuning their program. The vast majority of people who think they're advanced are really what we would call intermediate in all domains of life. Fair. Even as a scientist, it's quite rare to reach that number of advanced. So I actually don't have any problem going to failure quite often. I'm also fine with people who don't want to go all the way there. You can get most of what you need getting what we call technical failure. So this is like, okay, that was really challenging. Boy, you started to have some breakdowns of technique. We're going to call that good. The only exception here, I want to point out, is people who are either novice or beginners, they really have no concept of what 100% means. And so I think it's actually very fruitful to take them to 100% just to give them a guideline of where it's at. Now, of course, do this on exercises that they are comfortable with or close. And maybe this is on a machine, maybe this is single joint movements or whatever it takes for them to have confidence. But actually, I don't think you should be scared of these. They're not really that much more dangerous than anything else. I mean, think about it. If you're going to do a front squat or any exercise and your one rep max is 200 pounds, is it really that much more dangerous to do one try at 205 pounds than it is to do five tries at 190 pounds? Is it really that much more? No, it's not. So you can do like we talked about in the first episode, you can do a repetition max estimate where you get to like 85% to 95% of where you think you are. And then instead of adding load, you just do as many reps as you can, google that number, and that'll tell you the conversion and estimate of what your one rep max is. That's fine. But also, I have absolutely no issue. In fact, I generally encourage it to take people up to that level. Certainly not day one or anywhere close to that, but at some point, let's see what you actually got. I'm just going to cut it off early. What I'm going to consider to be 100 max, anything more than a minor technical breakdown for that crew, we're going to stop and call that good. And ideally with a spotter, especially bench pressing. Don't bench press alone in your basement kind of thing. A few people die each year from bench pressing alone in their basement or use dumbbells if you're going to do that. Harder to die using dumbbells. I suppose you could drop them on your head or something but not get stuck under them. Exercise selection and frequency of exercise implementation across the week. So I can imagine with this three by five routine done three to five times per week, you could imagine changing up the exercises every workout. Although considering that most of these three by five routines are going to be done with compound movements generally, sooner or later one runs out of movements if the goal is to hit all the major muscle groups. However, let me give an example and ask if it's okay to, for instance, do the three by five routine where one of the exercises for back is say, a bent over row. You do that on Monday, Wednesday and Friday. Okay. I can imagine one could do that and still recover and improve over time. But five days a week, bend over rows five days a week. Is that okay? Can one still progress? And there I could imagine it's a strong answer of depends because some people recover more slowly than others. I'm very comfortable doing hitting muscle groups once directly per week and once indirectly. That's worked for me far better than two

or three times per week. I get looks of sympathy when I say this, but it's just how my physiology works kind of, yeah, well, and maybe I'm not optimizing a number of different features, but the point being that some people really do seem to be able to train a muscle every day and still make progress. Other people seem to have trouble when they train a muscle every day. So how does one establish exercise selection when the goal is to make progress? And this brings up something very important and we're going to have a whole episode about this, but local versus systemic recovery. Is the whole nervous system becoming fatigued and is the muscle group and the related musculoskeletal systems becoming fatigued? We're going to go back to thinking about when you make these comments about it takes you three to five days and you've got better results in there. The assumption that you're probably running under is your training style is more reflecting that recovery time than it is your physiology. It's not you, it's how you're training. So if you look at, again, all the Olympic weightlifters that are competing, they're going to be squatting or some variation of squatting every day. That's going to happen. A lot of the times they're training multiple times a day and they will be doing some basically barbell full squat multiple times a day, every day, six days a week, something like that. They're the best in the world at getting powerful. They're tremendously good at getting strong. You can do it right. It comes down to what does your volume look like? What type of movements are you doing what rep range, what overall volume are you hitting, and how are you doing it? If you look at athletes, they train their legs every day when they're running around, they're doing speed and agility training every single day. They don't need three days to recover. Can you imagine a basketball player trying to ask for like three days to recover between practice? Right? Well, to be fair, as you chuckle at me, I'm doing other things on the intervening days. So I'll train a muscle group, like legs, and then I'll give it four days before I do an indirect, what I call an indirect exercise for legs, which for me would be sprinting. Then I get two days and then I'm training them again. But nonetheless, an athlete has to do that every day. Right? So the answer is you absolutely can train any of these muscles every single day. It really comes down to volume and it comes down to movement type and how are you getting it? So in the case of weightlifters and athletes, what we tend to see happen is there's two things. There is a long period of conditioning, and I don't mean endurance. What I mean is tissue tolerance and conditioning. So they're not going to start off their career at that pace, right? Their career might start off at five days a week, but maybe every other of those days is a PVC pipe only. And you're just training the movement patterns, you're working on technique, et cetera. And then eventually, maybe after six months or a year, those PVC pipe days turn into barbell only days. So now you went from a pound to 45 pounds, and then eventually, as your years go on, that ratchets up. So it depends on the style in general. Speed and power stuff is so light, it almost requires because it's non fatiguing, it requires almost no recovery. So if you were truly doing, say, like when you say it's funny because when you say, I do legs on Mondays, you don't even realize it. But an athlete does legs every day, right? But you're saying legs, and what you're really saying is, I do hypertrophy legs Mondays. Pretty much. I don't want to get into what I do specifically because it's less important than what other people choose to implement. But the repetition ranges anywhere from four to twelve. Correct. You're smack dead in the peak soreness longest recovery range. Volume is relatively low, intensity is very, very high, workouts are very short. So if you were to switch that and you were to stay under

four repetitions, higher quality, higher rest in between them, I would be willing to bet a large amount of money that you'd be fine the next day, certainly 48 hours. And if you were to actually go way lower and keep three to five and keep it very, very light and train for speed, you would have absolutely no issue the next day. So it really comes down to a function of training you're right in that hypertrophy zone, which is something that you probably need 48 hours at minimum to recover from. Because what you won't see are bodybuilders training the same muscle group on multiple days, like very often. At most it would be indirect, but generally they're not going to do that every single day for the same reason. So you're training in that style. That's what it's going to take to recover. If you trained in a different style, then it wouldn't take that long to recover. So for the person starting out, would you recommend they pick

three to five exercises and stick with those so that they can get their skill and movement and positioning and breathing, all that really dialed in, and then start to experiment by varying one or two of those exercises over time? That's great if you look at the conjugate model. So these are the strongest power lifters as a collective group that ever existed. What they're very good at is they keep almost the exact same weekly structure, but they make a very small change in exercise variation. So for example, say Wednesday is bench day, right? They're going to always bench on Wednesdays, but maybe this week they're going to do closed grip bench, and then maybe next week it's going to be maybe a special type of barbell. And then maybe the week after that maybe they'll change the range of motion a little bit. So it's actually the exact same exercise where they're making a very small variation. And that change alone allows them to do enough specificity, but also gives them enough variation to where it's not the exact same stimuli in the exact same spot over and over and over. And that's what allows that group plus lots of other assistants, but it's what allows that group to train very, very heavy, very consistently and not have to worry about too much planning for beardization and other stuff like that. They get their back off by making small variations in exercise. I will say a major mistake folks do make is they change their exercises entirely way too often. If I were to have to pick one or the other, I would say don't change anything on your exercises for six weeks, probably realistically, maybe even ten to twelve weeks. And then you can make some changes. You should not be changing every single week. You're not going to see progress. It's going to be very difficult to do that. So it's going to take you three weeks generally to figure out the groove of the exercise, to figure out how well you can load it, what's too much to where you woke up unbelievably sore. That was a train wreck. How much do I load it at? What position? How long is this going to take? It's going to take you three or so weeks and then you can really start pushing there. So changing it before that or. In that time frame, you're not going to be able to progressively overload because you're just not going to know exactly where you're at on all the exercises. So it's very important to create standardization within them and then see some progress in a movement or a muscle group, whatever you're going for, and then make some changes. So before we dive into our discussion about hypertrophy, can we just get a brief recap of the general parameters for an excellent power and strength training program? Okay, let me hit you with these rapid fire, and then you can maybe come ask questions along that. Remember those modifiable variables. So let's go through them in order and then what they mean specifically for power versus strength. So modifiable variable number one is called choice. So which exercises do I select for strength in general? For power or speed or strength, we want to select compound movements. You don't often see people doing maximum strength work for, like, a tricep kickback, right? It's typically multiple joint movements and typically complex movements. In selecting these compound movements, we generally want to actually think about exercise selection of movements rather than muscle groups. So this is an important distinction because we'll see this is a different answer when we get hypertrophy. What I mean by that is when we think about, again, strength training, we tend to think about bodybuilding concepts. We go to the gym and we do things like, I got to make sure I get my chest today, and I got to make sure I get my hamstrings. Now you're selecting exercises based on a muscle. You want to work for strength development and power. We want to think about movements rather than individual muscle groups. So there should be, like, things like, I need to train explosive hip extension, which is like a vertical jump or something like that. I want to train pushing or pulling movements, or I want to train rotation, which is a whole area we haven't gotten into, which is very important for overall health and wellness and longevity. So we want to select big movements by the muscle, the movement patterns that we want to introduce, and we just want to select a reasonable balance between these. I don't care what the exact ratio is. You just don't want to go an entire six months without doing anything in this rotational area or an entire eight to ten weeks without doing something that's a lower body hinge, right? So any number of examples there. So just think about the rough movement patterns, upper and lower push and pull, and then some sort of rotation that puts you in a pretty good spot if you're using three by five method, and you're going to pick as little as three exercises, just pick one from each one of those group. Pick a rotation, pick a push, and

pick a pull. I can easily think of a push and a pull. So, for example, bench press or shoulder, press row or chin for pull and then squat or deadlift for hinge. What would be a good example of a quality rotational movement? Yeah. So anytime you can use a cable machine, like at the gym, and you can do it's kind of hard to describe this exercise, but basically you're going to stand facing the cable and you're going to pull it towards yourself and then rotate like you're pivoting. Like you're either swinging a golf club or hitting a baseball bat. So you're facing one direction. I'm facing you right now. I'm pulling the cable towards myself. And then I'm going to spin, do a 180 degree pivot and face exactly away from you when I finish and then return it back to that same spot. So that's a rotation. Great. We will provide a link to an example of that that you consider a quality example, a medicine ball throw. Any number of things like this are a great rotational exercise. All right? So we select our exercises based on that. Because of that, as a case, we don't worry about things like eccentric versus concentric because you're generally doing a whole body athletic movement, which the eccentric concentric portion is going to be folded into that and you really can't separate them out. All right, so that's exercise choice. Our first variable. The next one is exercise order. So because everything driving power and strength is quality based, you want to do these at the beginning of your workout. You would not want to do anything fatiguing before this. So no cardiovascular training, no other repetition to failure stuff. If you do those before and now you're slower, all you've done is practice getting slower. These need to be done when you're fresh. You also need to do them when you're very fresh because they are the most neurologically demanding. They're complicated, they tend to have multiple steps and they're often in multiple planes. And coordination is a difficult thing. And if you're trying to do all that at maximum speed, your nervous system needs to be tremendously fresh. And so any amount of fatigue here is only going to compromise results to kind of recap. That. One of the major mistakes when training for strength and especially power is people worry way too much about fatigue. Those things should not be part of the equation. And in fact, if they are, that's a very good sign you're not doing this correctly. These are non fatiguing movements, especially speed and power. So choice order is next. The next one after that is volume. And we sort of hit volume and intensity, which is the other one we talked about that the volume is basically identical between power and strength. The general number we're going to look at here is something like three to 20 sets total per workout? Per workout. But that would be like 20 would be a little bit of a special case. Three to five is what I told you earlier right. I'm just saying sometimes you can actually go quite higher in cases, but that's the general range. And once somebody finishes the three x five workout for power or strength, if they decide they want to throw in some calf raises and curls and totally a forearm work or a little bit of jogging on the treadmill or something, that's okay. Absolutely. You have very little risk of interference for things like speed and power. Strength. You have a little bit of a risk only because now you're introducing fatigue, which if you're really pushing strength, that might compromise your recovery. I could imagine doing the three to five routine for strength or for power, and then somebody finishing up with ten or 15 minutes of hypertrophy arm work and then being very seriously compromised if they try and come in the next day or even the next day. Correct. And do those big compound movements for speed and power. That's right. Not just because they're sore, but the muscles may actually still be damaged. And I know

later we're going to talk about the somewhat tenuous relationship between soreness and recovery. Yeah. So that's a really nice heuristic to pay attention to, is you can but just be careful. Energy starts to matter at that point. If you're really, truly trying to maximize strength, you would do nothing at all outside of that training. If you're just like, I kind of want to get stronger and some other things, and you're willing to lose strength, 5% of your strength gains, then you're totally fine. The same can be said, by the way, for supersetting. So supersetting is an idea that says, like, wait a minute, you're telling me, dude, I got to take five minutes in between each set? Well, that's not so much a problem nowadays with smartphones because people are filling their intersets with social media and texting. Correct. You don't really have to go that long. In fact, there was actually a study that came out in the last month that showed, like, really two minutes is probably sufficient for most

people. Having said that, if you really are trying to push maximum strength adaptations, like three to five is very reasonable. Those training sessions are long because you're spending more time not doing anything than you are doing something, but you're trying to maximize quality. So that's just sort of like part and parcel. If you're not super worried about it, you can actually do supersetting, which is let's imagine again you're going to do some lunges, and while your legs are resting, doing their three to five minutes, you can go over and do an upper body row or pull, and when your upper body's resting, you're going back to legs. So that really cuts your time in half. Is it ideal? No. We actually ran a study maybe ten years ago in our lab and we looked at that specifically and we did see a reduction in strength performance in the supersetting group relative to the group who did not superset the question. Then it becomes like is it enough for you to care? So if I were to say, hey, I can cut an hour off of your workout time but you will lose 5% of your strength gain, almost everyone would take that exchange with the exception of people who are getting close to competition or really trying to set a new lifetime PR or something. Then you might say, no, I don't want any interference there. That last little margin is what I care about. Give me the extra rest. Great. So does it work? Does it not work? It's always what are you willing to give up versus get the practicalities of supersetting or staggering push, pull, push, pull in my mind are real because you have to take over large segments of the gym which oftentimes leads to a situation where your rest times are too long or highly variable because people are working in. Or you can't finish your set because now someone jumped into the machine. Totally screws. You lose three to five of your friends because it's obnoxious when you're taking over all the equipment. But in all seriousness, I think it's wonderful if you have the space and the format to do it. But at least in my experience and observation, these people know who they are. It's not practical to do on a regular basis if you train in an open commercial gym. Yeah, tough to pull off. So we've covered choice, order, volume and intensity to a sufficient level. The last one is frequency and we've already sort of indirectly talked about that, where frequency can be as high as you'd like in this area. It really depends on your recovery. If you're really, truly pushing maximum strength you probably do need a few days to recover, although that's dependent upon you. But speed and power can be done multiple times a day, almost every day. Basically the one exception would be maximum sprinting speed. You need to be careful there for things like hamstring and injury, especially if you're pretty fast. So you want to be a little bit cautious of that. But if you're doing easier movements like medicine ball throws or kettlebell swings or something, you could do those quite often as long as the volume is staying pretty low. Last little piece here is progression. How do I progress over time? So I mentioned this earlier, but just wanted to fill this gap right back in before we head over to hypertrophy which is three to 5% increase per week of intensity in general. And you can do upwards of about 5% increase in volume per week over time. And I generally recommend running that for at longest eight weeks. But probably most realistically you want to go about five weeks or so and then have some sort of a deload or back off week. If you do that you're generally going to be in a pretty good spot. So those are like the core concepts. Now, there's a whole bunch of fun methods you can play within all these categories, and I would like to actually cover just a couple of them if we've got a little more space for that. Sure, I'd love to hear about those. I'd like to also just queue up one, which is while I joked about people texting and doing social media between sets, that's not a joke. Well, I confess I stopped bringing my phone into the gym because of the urge to take my mind off of the workout. And I just started enjoying my workouts a lot more and the workouts go far better that way, and they're just much more efficient for me. I realize that some people, their careers take place in the gym, and so I don't look down upon anyone using their phone at the gym, but that really tends to help me. But I do wonder whether or not there's an optimal behavior or mindset in between sets. I've heard before that pacing around can actually help diffuse some of the lactate and other metabolic byproducts of work and exertion that can lead to better performance. I've also heard that shaking the muscles out. I mean, there's all sorts of gym lore about this, but maybe there's also some decent science. I'm just curious if you have any specific recommendations that people could play with or try. Yes, so for speed and power, you want to walk this

balance of stiff but fresh. And so if you were to literally finish a repetition, sit on a bench for five minutes, you would stand up after that fairly stiff, and you wouldn't feel sort of smooth. This is all non science. This is all practical application. Right. Anecdota anecdota. There you go. Strength is a little bit different, but it's the same concept. You're walking that line in general, a lot of the times, if you see power lifters and weightlifters in between sets, they're going to sit down and not move. For hypertrophy, it can be a little bit different because you're getting towards fatigue. And so the factors you mentioned, like clearing lactate well, first of all, lactate is not actually causing fatigue. That's a giant myth, which is why I teed it up. No, I'm just kidding. But in the case of, again, speed and power, you're not going to fatigue. So fatigue management is not really an issue. You want to make sure that you're getting complete neurological recovery, which is a little bit slower than muscle energetically. You're not out of any gas whatsoever. Right. You are not at a lack of fuel doing three repetitions of a vertical jump. Yeah, no clue. Plenty of glycogen. Totally. What about stretching between sets? Yeah, you probably don't want to do that either. There are very clear examples of pre exercise stretching, static stretching, being quite detrimental for maximum power production. The same thing for speed and strength. And that's been shown actually a number of times in a number of laboratories, which is like a classic hallmark any scientist looks for, of really jumping on board with an idea. If it's shown not only multiple times but in multiple laboratories from multiple scientists, and they're all seeing the same thing, you start to get a lot of confidence that that's a real finding. And that's been shown. We've done that in our center for Sport performance. Not myself, but one of my colleagues has done a lot of stretching research and he's seen that a lot on everything from vertical jump to isokinetic dynamometers and force velocity curves. And we've seen this in sprinting, we've seen this in speed, we've seen this in loaded stuff. So you don't want to spend a ton of time stretching statically stretching a muscle prior to if you do that and you have to do that, say for example, you finish that, you're just like feeling really tight. Yeah, go ahead. You need to get in the right position, especially for most people. Where are you willing to sacrifice 10% of power to make sure you don't get hurt? Yes. That answer is almost always yes outside of some very specific athlete scenarios. So if you're not in the right position I actually remember having this conversation with Kelly started a long time ago. It was just like, yeah, fine, I'll lose 5% if that means I'm not going to get in a bad position and hurt my back. And I totally, totally agree. So if you got to open up a hip or ankle or something to get there, get in the right position. Number one, we'll live with the 5% reduction in power. And if you do, just reactivate. So before you go do your working set, go do something fast again, a vertical jump, a short sprint, an acceleration, and sort of get that system cleared back up. If you didn't stretch it for long enough and you didn't hold it for long enough, you should be able to be just fine. So when it comes to hypertrophy, you can really stretch all you want because it's not driven by intensity or outcome, it's being driven by an insult into the tissue. And so if you're pre fatigued for hypertrophy, it doesn't matter. If you're pre stretched, that doesn't matter. We're not going for quality of outcome, we're going for quality of internal signal, which is not going to be changed by your force output. So it doesn't really matter. You mentioned a few other things that one might consider in light of the list that you provided of choice, order, volume, frequency and progression. Right. So starting off with power, I just wanted to hand the listeners here with a whole bunch of different methods to go play with. So as long as you hit those concepts, the repetition range for power 30% to 70% of your one repetition max, depending on the exercise and your training status, you're going to get the power. As long as you're attempting to go fast, it's going to be great. A lot of things you can try plyometrics are a great example of things that are effective for power development. We've mentioned medicine ball throws, short sprints, you can even do sprints on an air bike, which is a great super safe activity. You can do them from like a rolling start where you kind of like get going a little bit and then you explode for 5 seconds and see how fast you can get. Or a dead start. Both of those are very acceptable weightlifting movements. So snatches and clean and jerks are tremendously effective. In fact, they are pound for pound, by far the most effective exercise choice for power development. Like

without question. So those are good ones. Clapping, push ups, speed, squats, these are all whole host of different things that you can do for speed and power development depending on your kettlebell swings. Another great one. All these can be done depending on your preference, exercise availability, what's at your gym or not gym, any of those things. If somebody is more focused on strength as opposed to power, what are the additional variables they should consider? Again, within the context of this overarching theme of choice, order, volume, frequency and progression, absolutely. It's almost identical with a couple of small exceptions. Number one, you probably can't do as many working sets per week for strength because now you're introducing a heavier load and that's going to represent some sort of fatigue load on the tissue, all those things. So you could probably get away with doing 20 sets of two of a vertical jump four or five times a week. You probably couldn't do that at a 90% on squat. Right? So the total amount of sets and the total amount of weekly load you can get to just needs to be lower and then the intensity, right, so we talked about that needs to be generally higher than 70% with some portion of that being working sets and some portion of that really truly being at 90% plus. Everything else is pretty identical. You still want to emphasize maximum speed despite the fact you may actually not be moving faster because you've introduced load. You still need to be attempting that, but you're going to be picking complex exercises. You're generally going to be hedging more towards barbells and machines. So this is a case where body weight training can be effective again, particularly for the upper body. But at some point you're really going to have to move past that because there's just a certain amount of load you can't put on the lower body with just your body weight. You get limited by how much you weigh or I mean, there's a couple of things you can do, but you're going to run out past that pretty quickly. And so when it comes to strength, they tend to be less athletic movements because we have to have a barbell on us. We have to be on a machine or something like that. And so that's a subtle difference in exercise choice. We need to also be careful about the eccentric portion and things like that where we don't have as much risk in like a speed or power one. So some of the different things you can play with there, we've talked about doing things like pushes and pulls. I also love carries. So a farmer's carry, pushing a sled, dragging a sled, all kinds of things. A yoke walk, all kinds of carry modalities that are very, very effective for strength. There's eccentric overload training, which we really haven't gotten into, but it's a really advanced technique where you can actually load at greater than 100% of your one repetition max, but you're only going to do the eccentric portion of it. So physiologically, you are much stronger eccentrically than you are concentrically for a variety of muscle tissue reasons, actually. And so imagine if you can do a bench press at 200 pounds. What you might actually do is load it to 220, and you would have a spotter and maybe even use it in a rack, and you would lower it down under controlled all the way to the bottom, and then stop, your friends would lift it back up the top, and then you just practice that eccentric portion. You would actually be able to lower, say, 220 pounds effectively, despite the fact that you wouldn't have been able to lift it back up. You don't need to start there, but that is a very effective method for increasing. In fact, one of my doctoral students right now is doing a project on this at USC, and he's focusing directly on this. And it's quite clear that's oftentimes more effective at strength development than anything else because you can actually just like in the speed example, where you want to actually practice moving faster. So instead of practicing at 100% of your one or max for strength, you actually practice at higher than that to get better at it. So that's another much more advanced tool. Please don't let me get sued by saying all that. Folks, be careful, make sure you're doing the proper exercise and your positioning and caveat, caveat, caveat. Okay? But outside of that, it's totally fine and safe. Yeah, with it, when people get injured, they can't train. Can't train. You don't progress, you lose progress. So certainly that's worth highlighting. So two more, little more advanced techniques that I want to throw out there, and one of them is called cluster sets. So cluster sets are there's a bunch of ways to do it, but imagine taking a mini break in between every single repetition. So say you're going to do five repetitions in a row. What you're actually going to do is do one repetition, set it down, pause for five to 10 seconds, and then do the next one pause, do the next one. Pause, pause, pause, pause, pause. So you can imagine

doing like a squat and you're going to go down, explode up, you're going to stand there, you're going to rack it out. You're going to kind of like shake back out, catch your breath, walk back in, do another one, rack it out, and you're going to repeat that until you've executed your three or four or five repetitions. And then you take your three to five minute break before your next set. That is an incredibly effective way for both strength, power, and actually even hypertrophy because you can keep the quality, the force output, the power output very, very high because you're getting these little mini breaks and you're not getting fatigue setting in. By the time you hit your, say, third or fourth or fifth repetition in that set, after repetition one, you start to see very small, subtle reductions in power output because you start to see a little bit of fatigue. You take those five to 10 seconds off, even up to 20 seconds, you can actually do it. You don't see any drop in force output over the course of the five. And so what you really have done is you've gotten five in this example, first repetitions, which is the way that we will kind of say it, right? So all five of those had the same quality as rep number one, which is, again, as we're talking, that's the driver in strength. And so that's the one we want to preserve. So it takes a little bit longer for some exercises. It's not very good. It's great for like a deadlift because you set it back down, shake it back out, regrip. Hard to do with the bench. You got to re rack it back in, then rerack it back out. It's like kind of a pain in the ass. So there's some exercises it doesn't work well with and some that it does, but cluster sets and a lot of research on those, very effective. Would you recommend if somebody's doing cluster sets that they do them for every session within that week or just this is an occasional thing, you could do it, this could be your training strategy. Yeah, absolutely. So you can really take it that serious. In fact, if you look at, again, the weightlifters, they will do cluster sets by default, not even trying. So say they'll do like a clean and then they'll drop the weight back out. They're supposed to be doing, say, a set of three, but almost always they're going to shake it out, regrip, and then pull it again. And sometimes their set of three takes like a minute, and then you hear it's funny because I set a triple PR. You're like, no, you did three singles. What's the difference between doing three singles and a set of three when you took a minute between each rep? I love that community. It could be your strategy. It could be like, hey, for this five week block, this is all my training, especially for your compound movements. If you're going to go to start doing some of the smaller movements, maybe you give up on that. It could also just be something you do for your one primary exercise for the day. So do that thing that is the most important first and just do it for that one and then the rest of them, you can kind of ditch it if you need to save a little bit of that time. It can also be something you do by feel. So you're two reps in and you go, god, I'm not feeling like poppy here. Like re rack it, catch my breath for a quick second and do it so it doesn't have to be ultra planned. I guess what I'm doing is I'm giving you an excuse to make sure you're super fresh for every rep it matters. The last one I want to talk about here is what's called dynamic variable resistance. So dynamic variable resistance is fixing the problem we have with what's called the human strength curve. So, theory of constraints. Again, you are only as strong as you are in your weakest point of the movement. So depending on the movement you do, this happens at a different range of

motion. Well, the deadlift is the easiest example also because we've done research in my lab using this stuff on the deadlift, so I can speak to it very directly. When you go to pull it off the ground, some people are going to fail right at the bottom, meaning they won't get the weight off the ground at all. Some people will fail just below the knees. That's likely kind of like the hardest transition period. And then some people will fail right at the top just before they can lock out. Okay, great. So what that means is at some point of that lift, you're going to only be limited by your strength in the weakest area. All right? So if you have a constant load on the bar in those other two parts of the range of motion where you are not the weakest, they're never truly being tested for their maximum strength because they're always being limited by the previous one. This is the same argument that we would get into if people ask about, what do you think about using straps, right? Strapping your hand to a bar for deadlifts, things like that. There's pros and cons here. There are times when you want to use a strap, and there are times when it's a bad idea. So what

dynamic variable resistance is, is either using things like a heavy band or chains on the bar, if you've ever seen people do that. So in my lab, we actually have a force plate on the ground, and then we have built in basically hooks in the front and the back so we can actually set. A barbell on top of the force plate where you stand on it, and then run bands from the back to the front, running over top of the weights. And so when you stand up, as you're going up vertically, the bands are getting tighter and tighter and pulling the weight towards the ground. So the weight is getting heavier and heavier as you stand up. So as you start to gain mechanical advantage in your positioning, you start to increase load because the bands are getting tighter and tighter and tighter. So this allows you to train that full part of the strength curve and to challenge your stronger areas with heavier weight and your weaker areas with lower weight. You can do the same thing with a bench press, you can do it with a squat. And any other exercise variation and dynamic variable resistance is incredibly effective for a number of things. You're going to give up a little bit because the total load you can put on the barbell is lower, because you're going to be adding, in large cases, several hundred pounds of band tension. And so pros and cons, it's always a game. It changes the curve. But it's a very good technique that people it's fairly easy to implement. It's fun. In fact, if you try this on a bench or a squat, you're going to be like the first time you give it a go, you're like, oh, my God, because the bands are pulling you all over the place. So you have to get very stable, very quick. Been shown a number of times, a handful of studies out of many laboratories, to be a very effective training technique, a little bit more advanced, but I wanted to throw that in there for the folks that are maybe just tired of sort of doing the same barbells and dumbbells and machines. And you want to try something different, a very effective technique. Sounds like fun. Yeah, it's great. With your permission, I'm going to read back my summary list of training for power and training for strength according to your description, and you can tell me where I'm right and where I'm wrong. I'm going to pick three to five exercises, and these should be compound exercises. So multi joint movements. I'm going to perform those exercises for three to five repetitions each. I'm going to do three to five movements total per workout, and I'm going to rest three to five minutes between sets. Okay. If I'm training for power, the weight loads on the work set, so not the warm up sets, but the work sets are going to fall somewhere in the range of 30% to 70% of my one repetition maximum. Yes. And the larger the movement, the higher that number goes. So on a squat, you're okay getting 50 or 60%. On a bench, you would not want to go that high. You would want to stay close to that 30% to 40% range. So the way you scale that up and down is dependent upon the difficulty of the movement. Great. If training for strength, I'm going to have my work sets be 70% or more of my one repetition maximum. Yes. And the only thing to add there is in the case of actually all of them, it's okay to go less than three reps per set. So a single or a double one or two reps time is also fantastic. So we use three to five as the concept, but less is okay. Going more than that is generally not a good idea. So less is okay, more is generally not okay. And then you listed off a number of really valuable I don't even want to call them fine points, but important points to keep in mind within each and both of these programs. One that really stands out in my mind is this idea of if I perform this three by five program, but I'm also including some hypertrophy work for arms or calves or muscle groups that might not be hit as directly as one might like during the three x five component. That's okay, but do that after the three x five training, and keep in mind that that additional work can potentially compromise recovery for the three x five power promoting or strength promoting program. The example being, for instance, if one does arm work on the first workout of the week or even the third workout of the week or the fifth workout of the week, and that arm work is higher repetition, hypertrophy. Directed work, it's reasonable to assume that it might impede some of the three by five power promoting or strength promoting training in the subsequent workout. So just to be mindful of that and perhaps throttle back on the intensity or the volume, or if my goal is strictly power or strictly strength, probably best to leave out other forms of training. Yes. Love it. One last little thing I don't think we did justice is intention. And the reason I want to go back to this now is because we've talked a lot about specific loads you have to hit and that's generally the case. But if intention is there, you can fudge those numbers in terms of how much load goes

on the bar. In fact, you can get as low as no load on the bar. A great example here is like a plank exercise. So you can do a plank in which you get in a position and you simply contract the least amount necessary to hold the position. Also, you could contract as hard as possible, pulling your scapula down and back, squeezing your core, squeezing your quads, squeezing your glutes. That is actually going to still help strength production because you're attempting to contract very, very hard, even though, quote unquote, the load is the same. That thing extends to weight on the bar. So you could theoretically see large improvements in strength at 50% of your one rep max if you're contracting as hard as possible. And so there's a lot and lots of different ways you can train for strength that are outside of this weightlifting weight training spectrum. And if you hear things like this and you're like, wow, I know, I read this book, or I saw this other coach who I got so much stronger that way. Well, if intention is there, those are absolutely possible. This could be anything from body weight, style of training. It could be very low load implement stuff. So a kettlebell, a light kettlebell or a ball, it could be single leg training. It's like all kinds of different methods. They will only work for strength, though, when you're past your first handful of months of training. If intention is there, and if it is, then these specific numbers and protocols don't matter as much. So don't get too caught up in them if you're not worrying about exercise quality. And this is very, very important because you mentioned earlier about how you stop taking your phone into the gym with you. One of our former students, Ramsey NinJam, is the head strength conditioning coach at the University of Kansas and he made a great post a couple of days ago where he gave sort of a tip of how do I improve training quality? And one of his tips is set your playlist before you go to the gym. And the reason is people spend so much time in between sets just finding the next song that they like. It makes their workout so long and so unproductive. So that is one strategy or do what you do, which is ditch the music entirely. When you don't have music or a phone to look at, you only have one job, you only have one thing to pay attention to. And what you'll find is the quality of the training will go up exponentially. You will feel kind of, quote unquote, bored. But that just means you'll go back to training and you'll get a lot more done because you have one thing to focus on. So you can get a lot more done when you avoid those distractions. And when you're doing strength, and especially power work, since it's not fatiguing, strength will be a little bit, but power won't be. People tend to get very bored. They're used to either feeling a pump or a burn or a sweat, and that's their perception of my quality of workout. These exercises will not hit that for you. So there has to be another metric you're looking at, which is, I'm going to try to move as well as I can, as hard as I can. That's going to produce your results. If you can't do that, then you might as well just not do these workouts, go do something else. You're just going to be wasting time. You're going to be burning a very low amount of calories. You'll have wasted an hour and you're going to go right back to the place you were. So be very intentional. There are actually some studies showing that music can enhance performance. We've done some of these in our lab. So what's that mean? It's not about the music per se. It's about the focus and intent and do whatever it takes to be very focused and intent

and you can actually get in and out very quickly and get a lot of work done and see a lot of results. Love it. Okay, let's talk about hypertrophy, a topic that occupies the minds of so many youth, young men, but also a lot of women. I think one of the really interesting progressions that's taken place in the last decade or so is that far more men and women are using resistance training in order to evoke hypertrophy growth of muscles for aesthetic reasons and for all sorts of reasons. What are the ways that people can induce hypertrophy? So not to correct you or insult you, but probably a better way to think about that question is really what stimuli do I need to give the muscle to induce hypertrophy? Now there are hormonal factors that are important, there are nutritional factors. But just to stick with the context of training, this is really going to frame a lot of our answers. And as you'll see, it's one of the reasons why I call hypertrophy training kind of idiot proof in terms of programming. Now the work is hard, difficult and all that, but the precision needed is a lot less than what we saw in power and strength. And so if you note there it's very important that you do it in this style with this intent and within these parameters. And

if you're outside these parameters, it's not going to be it. Hypertrophy has a very broad range in terms of your actual applications. And this is why you have and will continue to see countless styles of training that all work. I mean, I know you were mentored earlier in life by one of my favorite people in this entire field, Mike Mensor. Like just an absolute character. His style was completely different than what you would see in a classic textbook or any number of different influencers or coaches or individuals. And if you've ever thought to yourself like, why is it all these programs work? And people love to jump to things like, well that's the steroids, just get that out of the equation for now. Independent of that, that's not even part of the equation. You're still going to see results. And the question is, like, why? Well, that's because what's driving changes in strength and power are the adaptations of specificity. What's driving changes in hypertrophy is much more well rounded and so you have options to get there. Remember, you're training a movement and now you're training a response and a muscle that caused the growth. That's very, very different. So if we look at like the classic dogma. We have to basically challenge the muscle to need to come back, in this case, specifically bigger, and then the nutrients need to be there to support that growth. The nutrients aside, perhaps we can come in a few more minutes and talk about that. So all we really have to do is going back to our dogma of activation of something on the cell wall we've talked about this earlier that's got to induce that signaling cascade. That's got to be strong enough to cause the nucleus to react to it, to go to the ribosomes to initiate this entire cascade of protein synthesis. Okay? So that signal has to be one of a couple of things. Either it has to be strong enough one time, it has to be frequent enough, or it has to be a combination of these things, all right? So I can get there with a lot of frequency and a moderate signal. I can get there with very low frequency and a large signal, like more akin to what you did with Mike back in the day, I'm sure, and still train that way, still train each muscle group mainly once a week directly and once a week indirectly. So all you have to do there to not fail is to make sure the training is hard enough. And it's going to work. If you choose the frequency path, then you actually have to make sure you're not training too hard to where you can actually maintain the frequency. The only wrong combination here is infrequent and low intensity and low volume. That's it. As long as one of those three variables is high, you're going to get there because the mechanisms that are needed to activate that signaling cascade are wide ranging. And this is why when we even see things like blood flow restriction training, right? This is when you put like a cuff on your arm or your leg and you block blood flow and you use no load or as low as, say, 30% of your maximum, and you take it to fatigue failure. That actually is an equally effective way of inducing hypertrophy, despite the fact that you're using 3510, maybe most 20% to 30% of your one rep max. Why? Because you went through the route of metabolic disturbance. Okay? Other ways, say a higher load, maybe as heavy as you can for, say, eight repetitions, is going to get through what's called mechanical tension. And so there's these different paths that we can get to the same spot. Now, eventually these things have a saturation point. So you don't need all three of these mechanisms. The third one, of course, being muscle damage or breakdown. I know we want to chat a little bit about that, but none of these three are absolutely required. You can have multiple of them in a session. You don't have to have breakdown at all. That is a complete well, really, it's a flat out lie that you have to break a muscle down to cause it to grow. That's just not needed at all. You have to have one of these three things, though. And so, again, this allows you a lot of flexibility, which is why crafting your program, which is best for you, is actually fairly simple when it comes to hypertrophy. You just have to make sure you do the work. And you want to make sure you have a few standards in place with the exercise choice and some other things that we'll hit in just a second. But that's really the fundamental way of getting to it, making sure either that signal is loud enough or frequent enough to give the nuclei a convincing enough reason to spend the resources. Because you have to remember two things. In order to grow new skeletal muscle, you need amino acids, which are your supply, and then you need primarily carbohydrates as the energy source to power that synthesis process. You remember basic chemistry that says if you're going to take two atoms and you're going to pull them apart or put them together, that's going to take energy. Typically in most of,

actually, metabolism, when you split a bond, you're going to get it's called exergonic. You're going to get energy from that. But when you put them together, that's going to take energy. This is why we call that protein synthesis, right? So you have to convince your nucleus that, one, invest those resources in energy, primarily carbohydrate. But number two, and more importantly, invest that supply. There's a ton of possible ways to get energy, but there's a very low amount of amino acids available, and you need them for many more things than just taking your biceps from 17 inches to 18 inches, right? It's not going to do that if you're in a position to where, again, you can't sustain immune function, if red blood cell turnover needs to be higher, or any of the other main, like, tons of things that you need proteins for. So you have to be able to say, like, are you sure you really want to spend these resources and build it into muscle? Because once we do that, it's very difficult to go backwards, break them back out, and bring the amino acids back into that availability pool. So we can use them for either another function entirely or even another muscle group. That's called protein redistribution, by the way. When you say maybe you don't do a lot of upper body work in your training and you're not eating enough protein or a minimal amount, and you're doing a lot of lifting in your legs, you'll notice your legs will get larger. But that's actually a lot of times you're pulling the protein from, say, your upper body in this case, and redistributing it back down to the quad. So that's what you have to get to. And in terms of application, what numbers to hit, we can go through each one of our modifiable variables just like we did with speed and strength and power and walk through some of our best practices in each category. Yes. So I'd love to talk about those modifiable variables as they relate to choice of movements, order of movements, volume, so sets and repetitions and frequency of training. And I'm particularly interested in frequency of training because that relates to the so called split where typically one is not training their whole body every workout, although there are, I'm sure, hypertrophy workouts that are whole body workouts but where people are dividing their body parts onto different days. So would love to go through this list one by one, starting with exercise choice. Cool. Great. So in the previous section we pretty much said exclusively choose your exercises by the movement patterns and you want to balance between pushing and pulling and rotation and things like that. In this particular case, you have the option to do either. Here's my recommendation. Most people default almost exclusively to choosing by body parts here, right? I'm going to do calves and shoulders today and chest and back, whatever combinations of things they want. That is clearly effective strategy. However, many studies have actually been done where you choose by movement patterns and that is actually equally effective. Now, one little caveat I actually should have said a few minutes ago. When we talk about the research on muscle hypertrophy, it is important to distinguish the fact that the vast majority of this research is coming from novice to moderately trained individuals. There's actually more and more research coming out on trained individuals, but that's still moderately trained, right? Even those ones. So what happens in those people that are actually way past that point? We don't know scientifically. It's very difficult to do research there. So it's an important caveat. I will acknowledge when I

say, hey, you don't need to do this or you have to do this. You were assuming a training status of moderate to low, may or may not be true. Past that, we don't know scientifically, I have certain thoughts personally, but the science will only take us that far. So that being said, you can actually choose by muscle or by movement pattern here, whichever is your personal preference. And this is actually where you can just become a good coach, whether you're coaching somebody else through this fitness journey or it's yourself and give them a little bit of autonomy. So maybe you select the first three exercises and then let them select one every day. And so if they especially want to make sure that one muscle group grows, let them target that muscle and maybe the rest of the day you've actually split it up as push, pull or something else like that. All those strategies are effective personal preference, as long as the total amount of volume on the working muscle is equated throughout the week, which we'll get to those numbers in a second, then you're going to be in the exact same spot, no problem. I would actually generally encourage people to choose exercises in a variety of fashions. I actually think that it's important that you do some

number of combination of what we call bilateral and unilateral exercises. So bilateral being think about it like a squat where bi meaning two lateral, you have 2ft on the ground moving in sequence. Here, unilateral is one. So this could be something as simple as a rear foot elevated split squat. It could be a single leg leg press or single leg curl. It could be a pistol squat, something where the individual limb is moving one at a time. You need to have a combination of bilateral and unilateral training that's good to do for strength as well. Probably not super important for power, but also very important for making sure for hypertrophy's sake you're not getting any imbalances as you progress, especially through months and years of training. So make sure you're doing a little bit of a combination. Whether you want to pick specific implements that's really a methods question and a preference question than it is concepts. So dumbbell, great kettlebell, fine barbell, awesome band, doesn't matter, body weight, none of these things are as important because all you're trying to do is create a certain insult in the tissue and the implement is just whichever one you feel best doing it. And this is where actually machines come into play a lot. Machines are greatly underappreciated. They are a fantastic resource, especially somebody who's either early in their fitness journey or somebody who really is having a hard time targeting a muscle group with a bigger compound movement. So when you're choosing exercises for hypertrophy, you're going to want to start with those bigger compound movements. That's going to drive a lot of the adaptation. You can get to these single joint movements like a little bit later. But having said that, because of the way that people move differently, their anthropometrics and their biomechanics and even their technique, the same exact exercise will not necessarily work the same exact muscle groups for multiple people. So if you and I both went and did a back squat, if you did it a little bit more of what we call a high bar squat. So this is the bar is literally setting up higher up on your neck. You're keeping your back more vertical and because in order to do that, you shift your knees much further past your toes, keeping of course, your whole foot on the ground in good position. Okay, that's going to generally put more of an emphasis on the knee joint, right? And so that's not a bad thing. You tend to see a little bit more work in the quads there a little bit less work in the spinal erectors and back because you're actually not supporting the weight horizontally, which is a much more difficult position. It's vertically stacked. Okay, if I were to do it in the classic low bar squat, which is, again, lowering the bar down further down my back towards more like my shoulder blades, I probably take a little bit of a wider stance, and when I squat, I drive my glutes back further away from the midline. In fact, as a general rule, if you take the midline of your body, the thing that moves the farthest away from that midline is likely to be the thing that's activating the most. So in the case of the front squat, you're not generally going to be using your glutes as much if you're in that, or not even front squat, just that high bar squat where you're very, very vertical. Your knees are going to be moving very far over your toes, which is fantastic. Therefore, it's a little bit more knee dominant. That's how we say it. The other version here, you can keep your shins really close to vertical. You move your butt backwards. You're going to have to then lean forward with your torso, which means it'll be more low back, more glutes, and a little bit less knee. Now, that's a general statement. It's not necessarily always true, but as a guideline there, that is one exact exercise where you may be going, man, I'm trying to improve this clear weakness I have in my quads. I can't even leg extension my body weight. I have a significant problem there. So maybe in your particular case, if I'm hammering you or you're hammering yourself in a squat exercise and you're wondering why your quads aren't getting any stronger or aren't growing in any size, it may be because of the style of the movement. So I may need to go andrew all right, look, squats in general, if you look at the research, are an excellent exercise for quad development. But for you, they're not because of the way you stand or just because of neural activation. It doesn't matter. So I need to take you to a machine and isolate that muscle group so we can make sure we see development in that. So if you're trying to grow a specific body part, area, individual muscle, it's very important that you're actually seeing progress there. And don't worry about well, in the textbook, the bench press is supposed to be good for your PEC. Because if you're not actually moving the right position or it depends on the angle in which your sternum actually sits in your

body, a bench press may actually be doing very little for your PEC. And you may need to adjust to, say, an incline bench or a decline bench or a PEC fly. So machines can be fantastic at letting you isolate without having to worry about things like stability, your low back position, getting hurt, where's your neck at. You can really concentrate on just the movement, concentrate on the muscle and let everything else kind of go away and ensure you're getting training in that specific area. Those are excellent recommendations. One thing I wanted to ask about is prioritizing specific body parts and therefore specific exercises. And here, I'm not necessarily referring to trying to bring up a so called weak body part, an area that tends to be either genetically deficient, because in some cases I learned, for instance, having seen a lot of competitive track and field championships, I love watching track and field as a spectator go up to Hayward Field in Oregon whenever there's a meet. Oh, sure. Really love that. The sprinters are amazing. They have some of the highest calves in the world that I've ever seen. I mean, like little micro calves. But they're fast as hell. They're right behind the knee and they have a very long distance between that calf and their foot, which makes it propulsion. Excellent. Right. They wouldn't stand a chance as a competitive bodybuilder. No, but because something different is being selected for in bodybuilding. But obviously they're magnificent for sprinting. Most people, of course, reside somewhere between the extreme of very long muscle bellies from origin to insertion or very, very short muscles. Usually people have one or two body parts that they want to emphasize for whatever reason. These days it seems to be people are really what are they saying now? Like glutes are the new biceps or biceps are the new glutes? I don't know. Anyway, you see this stuff? I love them both. By the way, I am so pro curls in the squat rack. There you go. Love it, right? There you go. Nobody kill me. So everyone has their thing but that they would like to emphasize. But I have a question because we're specifically talking about hypertrophy which is should people give themselves permission to not train a body part if their goal is balanced hypertrophy? I'll give a couple of examples. One of the reasons why I've, for instance, not done a lot of free weight squatting is because despite my quadriceps being rather weak, according to you, they tend to grow rather easily relative to other muscle groups. And the goal for me has always been balanced development. And so I emphasize hamstring work and I emphasize calf work and hamstring work. It's not that I don't train my quads at all, but I do far less for them and I avoid the big compound movements for them. I occasionally do them. And again, this is not about what I do or don't do. But I think that in the context of a conversation about hypertrophy, is it appropriate to give people permission to say, listen, if you're just genetically strong large lats doing a lot of chin ups and rows might actually be the worst thing for you if your goal is balanced development. And I ask because I don't often hear anyone any credentialed. People give people permission to completely avoid training a given body part if their goal is balanced development. And yet I think most people who. Are resistance training, are seeking balanced development. I don't know anybody that actively wants to have big upper body, small legs. I think that comes from neglect and laziness in most cases. Sometimes it's injury related or other things. But I think this is an important point to raise that. Any good program for hypertrophy, I would think, would have to take into account people's genetic and natural variation, sport based variation in which muscle groups just tend to grow easily for them and which ones require a lot more focus and work. Yeah, absolutely. First of all, you have permission to do or not do anything you'd like to do. In terms of hypertrophy training, I generally would not recommend disregarding a muscle group entirely. I know that's not what you actually suggested, but just to make sure that people didn't hear it that way. What I would do is in this example, is I would continue to do those big movements. I would just keep the volume low so I might do two sets or something twice a week. There's a whole bunch of reasons you want to make sure that those motor patterns are there. You want to make sure that especially the benefit of these compound movements is you get to work so many complementary muscle movements at the same time. So in the case of, like a loaded squat, you're not only working stability in the hip as well as the knee, but you're also working upper body. Your rhomboids are keeping you in position. Your neck has to stay in position, your toes, everything is working. And so it's really difficult to get those things when you take that movement out and you

replace it with, say, a machine hamstring curl. That whole element of balance, neurological control is very, very important to maintain over time. And that just gets removed if you go to machines only. So I would keep some of those things in maybe even not all year round, but maybe one quarter of the year, two quarters every other rotate it something like that. As long as if the reason you weren't doing, say, those squats was because you're like, it hurts my back or something. Okay, great, then leave it out. But if it's just simply you don't want your quads to go too much, I would just keep that volume low and do something just to kind of touch it, keep it activated, and to maintain all those other things like flexibility, range of motion. I would bet anything your Adductors are probably underdeveloped right now. You can get those by doing your squats because you're not really doing, I'm sure, much Adduction training. And so there's things like that that just get lost when you're only thinking all big muscle groups that come inherent in doing the larger movements, and so you don't have to worry about them or train them separately. I appreciate that. And in reality, I do two to three really hard work sets of hack machine squats per week, which is plenty for me to maintain and even get a little bit stronger. But per our earlier discussion, about a year ago, I shifted to doing very low repetition ranges to main strength in that movement. There you go. But I am actively avoiding hypertrophy in that muscle group. Yeah, or another solution would actually be do something like one set to failure a week, not even extremely long. Just do something in the eight to 15 repetition range at the end of all that strength set and just get a little bit of pump there and end it so just so that those muscles can touch that level of fatigue, touch that level of strain and mechanical tension, walk away. Great, thank you for that. What about exercise order? Amazing. So implicit in this exercise choice thing, what you're going to notice is these modifiable variables interact with each other, right? And you can clearly see how when we talked about volume, and to clarify, volume is the repetitions multiplied by the sets. That's typically how we express volume. Well that's going to be directly influenced by intensity. The heavier load you put on the barbell, the less repetitions you can do. And the inverse, right, rest intervals, the shorter you keep your rest intervals, then either the lower the weight has to go, the intensity, or the lower the rep range has to go. Order is the same thing, choice is the same thing. So all of these things modify each other. They play a little bit of a hand in what everything else does. So with the exercise choice thing, rolling into exercise order, you get to play a couple of games here. When we talked about strength and power, I basically said stick to the big movements, most complicated and compound movements first. You don't have to do that with hypertrophy. You can do this in a couple of ways. You can do the thing you're just simply most interested in first. You can do this thing called pre fatigue. So say you're going to do a back day. You could go in and do nothing but isolated biceps as your very first exercise and then roll into your pulling movements. Because what you'll see is during most pulling activities, the biceps are a secondary or tertiary muscle group. But you've pre fatigued them, you've guaranteed that muscle of most interest got its most training in, and everything else is secondary. So you can start if you want with single joint movements, you can start with isolation stuff or you can start with compound stuff. Either way it just really comes down to preference and what you're specifically trying to develop. Now this also goes back to the exercise choice question, right, because it's sort of the same thing, right? Like which? 01:00 a.m. I choosing and where I wanted it to cap. This was the exercise splits. We just sort of talked about am I doing body part splits. And I know a question I get a lot here is, well, which ones should I package together? I'm not really concerned with it. All you should worry about is how many times per week and in fact total volume you achieve on a muscle group per week. And it doesn't really matter how those things are folded in, it's really a personal preference issue. One mistake that we see here commonly is grossly underappreciating that the legs are not a muscle group, right? So the legs have a whole bunch of muscle groups in them. So we see a classic split like I'll do shoulders and chest Monday, and then I'll do biceps and forearms Tuesday, and then legs Wednesday or whatever, and then back to upper body. And then I was like, you're like, wait a minute, you have four days dedicated to the upper body and one for quote unquote legs. Well, hopefully you can see the imbalance that's going to happen there over time is you're going to do far more upper body than

you are lower body, and that's not appropriate. So you just want to think about your lower body like you would do. If you're going to do body part splits, then include those things as well. And don't just chunk everything in as legs once a week. If you want to do that, that's actually okay. But that day has to be very challenging and you probably should do quite a bit of volume there because you're almost surely not going to hit the total weekly volume needed to optimize muscle growth if you're literally only doing once a week of your quote unquote legs. So along those lines, let's talk volume. How much volume does each muscle group need per week in order to generate and for that matter, maintain hypertrophy? Right? So the kind of minimum number we're going to look for here is ten working sets per week. Correct. Per muscle group. Correct. And just to make sure that everyone's on the same page, if I do a chin up or a pull up, I'm going to mainly be training my back muscles, my lats, if I'm doing it correctly, lats and rhomboids and biceps. Right. But there'll be indirect targeting of the biceps. So would you include indirect targeting? So for instance, if you said ten sets per week, let's just use biceps because it seems that that's the go to generic muscle. Why is that, by the way? That when people ask somebody to flex their muscle, they always flex their bicep, they don't flex their calf or their quad or their glutes or something. I guess there's some public decency issues. I can tell you with my children that's the very first muscle I taught them to flex. Their glutes. No, they're biceps. I got what I was going to say. Good healthy parenting advice from Dr. Andy YELPIN. So if it's ten sets per week for biceps in order to maintain or further grow the biceps. But does that mean if somebody does ten sets of chin ups or ten sets of chin ups and rows that they are checking off any of the boxes for biceps? Assuming that they're doing the movement properly and targeting the major muscle group that a given movement is supposed to target, which in my mind, when you're doing chin up, you're supposed to mainly be using your back muscles. And then there are secondary muscles or secondary activation of other muscles. But of course, some people, their arms grow like crazy when they do chin ups and their back doesn't grow at all. So this is where we're back to the kind of genetic preloading of the system, if you will. So how does one meet this ten sets per week minimum when dividing different body parts and thinking about this direct and indirect activation? So, two things, there's no specific exact rule here. And this is why these set ranges are ranges, right? And this is why we don't say like ten is. So ten would be sort of the minimum number you want to get to. The more realistic number that most people, especially if you're advanced or even intermediate, is more like 15 to 20 working sets per week. Now, if you're very well trained, you probably want to even push more towards like 25. And in fact, past that, there's just not a lot of research. So the optimal number may be 30. We don't really know. It's just hard to get that much work in. It may actually even be detrimental. And here we're referring to natural athletes. That is, people who, for whatever reason, either because they're not taking any prescription drugs or maybe if they are, whose levels of steroid, hormones, mainly the androgens like testosterone, et cetera, do not exceed the normal reference range values, either because that's what they

are naturally, or that's what they're replacing through pharmacology. Whereas when we think of technically, someone could be taking exogenous hormones to replace a deficiency and then they're still in normal range. Okay, but I just want to clarify, because you work with athletes in a number of different sports where drugs are and are not tolerated, et cetera, and the general population, that what we are talking about here is for the general population, not for steroid using athletes, correct? Okay. Yeah, correct. So ten was just sort of that like absolute minimum number to maintain, which is actually pretty cool if you think about it this way. If you went in and you did three sets of ten, three sets of ten repetitions. Correct. You're already at three. You did that three days a week. You're at your nine. That's almost ten. If you also just went to the gym one day a week, you did three sets of ten and you did three exercises, you're at nine working sets. You're basically done. So achieving ten sets per week per muscle group. And now we're not even talking about indirect activation of a secondary. So you're going to hit ten. Fairly easy extension of that. Hitting 20 is actually still not that hard because of what's actually going to happen there. So in your example, if you're doing your chin ups well, would the biceps count? There's no exact rule there because there could be technique

issues, it could be hand position. So you mentioned chin up very specifically. A chin up is actually going to put your hands in this position where your palms are facing up, right? This is supination and pronation, so you're going to be there. Well, that's actually quite different than a pull up where your hands are in the opposite direction. So a chin up actually is going to be pretty good activator your biceps for most people. So you would expect actually to probably count that because it's going to be very difficult to not see some fatigue in your biceps, depending on your mechanics, depending and by that I mean just the segment lengths of your bones. That's where your muscles originate and insert. There's nothing you could do about it's, not even a technique or a focus issue. It's just simple fact. The matter of that's, how you pull best in that area, the position of which your hands are on the bar, wider grip, more narrow grip, it's going to change muscle use. So we talked about earlier, I think, in the previous episode, that exercises do not determine adaptations, applications do, but exercises do determine things like the movement plane, the joint you use, and typically the eccentric concentric sort of ratio, as well as oftentimes the muscle groups involved. So there's just not a lot of things you can do depending on how you are built of some exercises activating a secondary group and you don't want it. So it's not always a technique issue. It may just be that's how you're built, right. And the same could be true for a squat. The high bar versus low bar. Sort of example we talked about earlier, you can see plenty of evidence on muscle activation studies, where people even doing the vertical back squat style have tremendous glute activation and folks doing the low bar have tremendous quad activation. So a lot of it depends on personal mechanics. So what I counted is the question really you just have to ask yourself, number one, do you really care that much? You know you have a range to get to. If you were anywhere between ten to 25 working sets, you know you're fine. So if you count it or don't count it, it's just going to change the difference between whether you did 17 working sets or 23, and either way you're fine, so I don't really care. Number two, are you actually feeling anything there? So if you're doing your chin ups and your biceps are blowing up, I'm counting that right. If you're doing it and you're like, no, I don't feel any fatigue there, then I'd probably say, okay, we're not even going to count that. So you can just let that guide you a little bit towards your count. Yeah. I've always noticed that there are certain muscle groups that are very easy to isolate when under load. And those are almost always the same muscle groups that are easy to contract very hard without any load whatsoever. Bingo. You nailed that's actually really insightful. So you can kind of use this heuristic of like if you can contract your lats just standing here, you're probably going to contract them very well when you lift. If you can't, you can probably assume about the same thing is going to happen. So, yeah, you'll know, the lats are actually really interesting because they tend to be one of the more difficult muscle groups to learn how to activate. So if you're in your journey and you're just like, I have no idea, and you can look up like a lat pose. So how do you puff your lats out? How do you show it? And if you do that and you're like, wow, there's no movement here, just recognize that's extremely common. And it's probably going to take you many months of trying before you start to see some movements and probably even a few years before you really start to see activation. So you're not some sort of specific special genetic anomaly. It's very, very common. It's uncommon to not be able to activate your biceps, right? Everyone can do that. But if you're just like, man, I can't get this here, I'm just going to stop doing it. Do not do that. Just keep at it and just keep concentrating and thinking about that muscle group. It will take some time. It's very common to have challenges activating lats. Yeah. I've noticed that many of the muscle groups that were responsible for a large fraction of the work in the various sports that I played as a young child are muscles that are very easy for me to selectively isolate and induce hypertrophy in. I suppose I'm one of those mutants where my lats happen to be one such of those muscle groups. But I think that's because I swam a lot when I was a kid, literally going to ask, were you a swimmer? Yeah. That's like a telltale sign. Yeah, every kid in my town swam and played soccer. There you go. And then later I skateboarded and did some you generally hear that answer, you either were a swimmer or you were a wrestler. So it's like that pulling and pulled toward you is thousands of repetitions allowed you to get very good at contracting. But because I also played soccer and skateboarding, but I didn't do

any baseball, basketball or football, muscle groups like Deltoids are very challenging to activate and isolate. So I do think that early development is superimposed on a genetic template that sort of predicts which muscle groups are going to be easier or harder to isolate and train. It's also a very good case for why it's important to do as many different athletic activities as you can in your youth. Yeah. And if you do skateboard, definitely learn to ride switch, because every skateboarder I know has one leg that's larger than the other and one calf that's larger than the other. And actually, for that matter, people that do martial arts that don't learn to if they're not southpaw, if they don't learn to switch up and do their work southpaw, you see the same thing. I mean, you're building an Asymmetry into the system, and it's not just muscular, it's neural. Strongly neural. So, yeah, kids parents get your kids doing a bunch of different things. I suppose gymnastics would probably be the best sport all around in terms of movement in multiple planes and activating all the different muscle groups. Yes and no. There's a lot of benefit, no question about it. There's a lot of other things, though, that has limited ability. So almost everything is not like gymnastics great, but almost everything in that is pre planned, which is a major downfall. Right. So the joy of skating is there's so much progressive input that you have to make decisions very quickly in small windows. Now, you have a little bit of that when you're flipping in the air and you have to land. But gymnasts tend to have a very specific routine that they're working on, and they work on that routine for years. Skateboarding, for me, was transportation. It was freedom, and it didn't require any coaches or parental oversight. Yeah. Ball sports have the beauty of reaction and things like that. So all of them are wonderful. Yeah. Good to do a lot of them. You've established that ten, really, to 20 sets per week is the kind of bounds for maintaining and initiating hypertrophy. Yeah. If I were to flag one of them, I would say 15 to 20 is the sets that you want to get working. Now. It gets complicated when you ask, how many reps per set do I have to get to? Okay, well, we also can complicate that by repetition, type and tempo. Just sort of let all that go for now and just think, if you're getting close to that range, you're in the spot. And all you have to do now is balance two things recovery and continued training. So if you're somewhere in this ten to 20 working sets range, and you're in a position where you can continue to do that, you're not so sore and so damaged and beat up that you can't maintain that volume. For eight weeks at a time, or at least six weeks at a time, then I'd probably say either. The style of repetitions, the amount of repetitions per set you're doing are too much. The volume is getting to you. However, if you're not seeing adaptations, then I'd say maybe the repetitions aren't enough. And so that's the kind of game you're running now. There could be plenty of other factors. Intensity, of course, yeah, intensity, intent, and then of course, the other things sleep, nutrition, et cetera. All these other things that go into our visible stressor category that we always analyze. This sort of brings up this idea of responders and non responders. So we get this one a ton. So why is it some people, my gym buddy, my roommate, we go

to sleep the same time, we're on the same nutrition plan, we work out together, she triples in muscle size and I don't have no gain whatsoever. Well, there's a lot of work that we're trying to do to identify the molecular mechanisms behind responders and non responders because they clearly exist. In fact, this is one of the reasons why every paper I basically will ever publish again, if I do, always reports individual person data. So rather than group averages, you get to see if there's ten subjects in it. You get to see how each of the ten responded because the group average can get confusing. What you really want to see is how many actually people got better, how many got worse, how many maybe changed. And if so, we'll always report those individual data because when you go to train you're, you, you're not the group average. That's very important to know. So if you do that, you can see a beautiful line of these hyper responders, the bell curve in the middle of the normal responders. And those folks who like through any training study, just won't get any better. If you can tease out, which you can't. But let's say in science you could tease out all the extra factors. Total stress, load, hydration, sleep, et cetera. What you often see is non responders. A lot of the time it's not that they have a physiological inability, it's just that they need a different protocol. And a lot of times they just need more volume. So if they can handle that and they're not excessively beat up, just

give them more volume and they tend to see a lot of breakthroughs. You see the same thing with plateaus. So it's typically sort of just like, okay, the routine you're on, you've been on it for too long. We need to either go to the other end of the hypertrophy spectrum for intensity, which means if you've been in the 60% to 70% of your one repetition max range, maybe we actually need to go heavier, take our repetitions down, maybe even our total volume down, and go heavier. Try that a great way to break through plateaus of grand. If all the other boxes are checked, the other one is do the opposite, which is like, okay, we're going to go higher, we're going to go set to 20, set to 25, very high repetition range. And really get after it, not do as much damage because you don't tend to get as sore from those really high repetition ranges. You'll get more sore from the lower repetition, higher intensity range than you will typically the other ones, and see if we can bust through some plateaus there. So it just generally means you need to do something a little bit different than your training partner. So we've talked about exercise choice and we've talked about the number of sets that one needs in order to induce hypertrophy per week. What about repetition ranges? You've mentioned pretty broad repetition ranges. How many repetitions per set is required in order to induce hypertrophy? Yeah. So there are two caveats here before I give you well, the number is somewhere between like four to 30 reps, 30 repetitions. Absolutely. In fact, I think you can go much higher. The first 20 have to feel exceedingly light. Correct. And during those 1st 20 or so repetitions is the goal still to contract the muscle as hard as possible on each repetition. So this is the caveats here. So caveat number one is there is an assumption that by the end of the set you're getting somewhat close to failure. And so you don't have to go to absolute failure to induce most like perturbate, but you also have to get kind of close. So if you're going to do a set of 25 and you finish it and you're like, OOH, yeah, that was kind of starting to get hard at the end, that's not going to be enough. If you're going to do a set of five or six and the same sort of expression comes out of your mouth, it's not going to be enough. So in that case, it doesn't matter your rep range. If you're not getting somewhat close to failure again, it doesn't need to be complete failure. Good number to think about is like minus two, which is what we call reps and reserve, which is sort of like I got within two or so reps of failure and then I stopped. And can we define failure, at least for sake of this portion of the conversation, as the point at which you can no longer move the resistance, could be your body, could be a weight machine, et cetera, that you can no longer move the resistance anymore in the concentric phase of the exercise movement in good form. Correct. That's a really nice momentary muscular failure is how we typically define it. There's a wonderful review, I think it's open access that just came out in the last handful of months. Eric Helms' team out of New Zealand. Eric is a great scientist and a very experienced physique coach and a competitor himself, so he knows a lot about this area. And that paper went through all the exact definitions in detail, all the caveats that we're not going to have time to get into today. So I would recommend folks like check that out. They want more information, but I'll try to get to the highlights of it. Right here. So what they basically showed is going all the way to failure in the defining failure like you just did, right? So momentary muscular failure, you can't complete another repetition through complete range of motion, through whatever range of motion you determined prior to, as well as with good technique, so other body parts aren't being compromised, sort of, et cetera, and doesn't need to be total failure. That minus two failure is still needed in caveat, too, which is, again, very, very highly trained individuals. You won't see people who are like Eric or other folks who are six to eight to ten years into very serious training, who don't have to go to failure, probably a little bit more than what I just said. So the layout that they brought in, their paper was very nice and they basically said, okay, here's a couple of scenarios in which going to failure is maybe the best way to do it. Number one, you probably should do it on a little bit of the safer exercises. So maybe taking your back squat on a barbell to complete failure and doing that as like a standard protocol multiple times a week, it's maybe not the best choice. So maybe if you're going to do barbell back squats, you take that to your one or two reps in reserve stop there. It's a lot of work. And actually, going back to our discussion of the prolife chart, it's a similar idea, right, where you're going to spend most of your time in these working sets, 70 to 90, sort of

percent, and then you're going to take that failure to maybe the hack squat machine or maybe even to the leg extension machine. So a little bit of a safer exercise. They also can tend to be single joint exercises, don't have to be, but they're just ones that are not as complicated and you're not likely to injure other body parts when you're doing it. All right? So that's one way to go about it. Another way to go about it is simply doing it on like, the last movement of the day. And so, again, you're not going to do it on your first three or four exercises, but whatever your last finisher is, you'll hit total failure on that one. And that kind of keeps you in a range of, yeah, you hit some failure, you got a lot of overall work done. So that's a lot of stimulus, that's a lot of noise going to that nucleus that says grow, grow, grow. But you didn't totally obliterate yourself, especially if you don't have the assistance of anabolic steroids, right? That's very important. If you have those, you can push this a lot harder because your recovery would be significantly enhanced. If not, you kind of want to walk away from that. I have to assume that 99% of people listening to this do not. And yet among those who are not taking anything in terms of. Anabolics there, I think, is a large range of recovery quotations out there. Some people just tend to recover better. Some people, I think, also are far more diligent about what I would call the necessary but not sufficient variables of adequate sleep, proper nutrition, limiting stress and so on. Yeah, I can't wait to break all that stuff down. I got a very long discussion for all those things. We will get into it in all its practical realities and actionables before long. What about rest between sets? Great. This is the interplay now. So one actually thing we said for a long time is you want to stick between 30 to 90 seconds of rest between sets for hypertrophy, and that's because you're trying to activate this metabolic disturbance or disruption. You need a little bit of a burn, a little bit of a pump to go there. More recent research, a lot of this out of Brad Schoenfeld's lab and others, have shown that that just doesn't seem to be the case again for moderate to newly trained individuals. Whether that's the case for the highly trained folks, I don't necessarily know. I don't think there's any difference here. So you can take up to three to five minutes of rest in between sets and be fine. The caveat here, though, is this if you're going to rest longer, that means the metabolic challenge is lower. So you need to then increase the challenge in either mechanical tension, which think about as weight, load, or muscle breakdown, so you can't lower one of the variables, keep everything else the same and expect the same result. So if you're going to have more rest, then you need to either preserve the load on your bar or the volume one of the two has to happen. So this gives people a lot of opportunity. I generally tell people if you're going to train for hypertrophy, it's probably best to stay in the two minute range. At most. You can go longer. But a lot of people have a hard time actually coming back and then executing that next set with enough intent to get there. And or it's going to make your workouts tremendously long. So you can stick to the shorter one. You don't have as much mechanical tension, but that's okay. You can still get there, but in reality of it is you can do whatever you would like. Tell me if this is a reasonable structure, given what you've told us. Three exercises per muscle group. First exercise, slightly heavier loads. So repetition ranges somewhere between, let's say five and eight, with perhaps hitting failure or close to it on the last set. Rest periods of somewhere between two, or let's get wild and say five minutes. Sure. Okay. So it's a little bit more of a strength type workout at that point, but then moving to a second exercise of three or four sets where the repetition ranges are now eight to 15 shortening. The rest periods to 90 seconds or so. And then on the third exercise, repetition ranges of twelve to 30. This number 30 kind of makes me wide eyed. I can't remember last time I did a set of 30 thinking it was for hypertrophy. But what you're saying makes absolutely sense and is research backed. So very short rest intervals, maybe 30 seconds between sets, would that allow somebody to target all three forms of major adaptation? In my mind, it works. You're talking about mechanical loads, you're talking about stress and damage, and you're talking about metabolic stress. Is that better than to, for instance, do all the high repetition work in one workout per week and then higher loads in the other workout? Does it matter if you divide them up or combine them? It would not matter. I would say it matters in the sense of your personal practical situation. Well, long rest for me. I love training heavier with longer rest,

great. But I'm hearing that there's real value to doing these higher repetition ranges. Yeah. So the formula you set up there in a second is great. If you want to do it the other way, that's fine. It's kind of idiot proof. You can set this up however you'd like. You could actually do the inverse. Theoretically, you could do the sets of 31st and then move to your sets of eight. It doesn't really matter because we're trying to just get to a certain total stimuli and you're going to hit it eventually. So you have a lot of room to play here. You also have a lot of room to adapt based on your circumstances. God, I'm short on time today. Typically, my workout takes me 60 minutes. For this plan I have, I've only got 35 today. What do I do? Well, if you're training for strength, that's a different answer than if you're training for hypertrophy. If you're training for hypertrophy, you need to make sure you hit that total volume. So in this particular case, lower the load, lower the rest intervals, and just get to the burn and get going as much as you can. If you're training for strength, I would rather you cut your volume in half, get those few repetitions done at that high load, and just don't do very many sets today. That's a better result. So the goal that you're going after is going to determine what we call chaos management, which is that thing like that running out of time. Today my time is short, or you didn't even think my time was short. Something got cut off, I'm not feeling it today, I'm in a hotel, et cetera, et cetera, et cetera, which is life. Right. That's going to be ten to 50% of your workouts is going to be chaos management. Well, how you make those decisions is going to go back to understanding, number one, what goal you're going after. And then number two, what are the physiological consequences we call these physiological limiters for each one. And that's going to tell you what to select and prioritize the volume, the intensity or whatever else. I'd like to ask about frequency, but I'd like to frame it a little bit differently than that. I'd like to ask about total workout duration, which dovetails with frequency because if one is hitting the appropriate number of sets per week and one is combining different muscle groups on the same days, well then workouts are going to be a very different duration than if one is doing a different body part each day, for instance. And so I feel like any discussion about frequency has to be within the context of workout duration and vice versa. Yeah, if you are a lifting junkie and you're very consistent in your schedule, I'm actually okay with body part splits. Most people are not that. And so the concern there is if you say are isolating and waiting to do your glutes on one day of the week and something happens on that day, you might go another 13 days now before training, it between workouts and that's really difficult to maintain. The frequency won't be high enough unless the load and volume on that one day is astronomically high, it's just not going to happen. So while, if you look at the research frequency in terms of how many days per week doesn't matter that much, as long as the total load and failure are equivalent, practically, it's a challenge. So it's hard because life gets in the way for most people, especially if you have kids and a job and all these things over there. So I actually prefer doing something more like three days a week of total body and if something happens, you've just missed that body part for 48 hours, 72 hours, I like that a little better for most people. Not because it's more effective, but just because it's a little bit more resilient to life. And you can get there if you wanted to actually do a little bit of a combination. So if you wanted to do like two days a week of whole body and then two days a week of a little bit of a body part split, then you're actually sort of hedging against all risks there as long as you get to that total number there. Now there is actually some evidence in a couple of ways that maybe a little bit more frequently is a little bit better. But the difficulty is now going back to the practicality question of like how many people really can train just their strength training six days a week. That doesn't count any of their long duration stuff. It doesn't have their high heart rate, their flexibility. Okay. It's just really hard to get all that stuff in. So it tends to be easier on folks in terms of execution and long term adherence, in my opinion, to get that volume accomplished in a little bit more frequent patterns, but not once a week. So I like to kind of have it right there for most people. Again, not because it is technically, quote unquote, more effective, but because you're less likely to fail to progress because of skipping a workout. Something popping up, your power going out and your garage door being locked on you or whatever. Imagine that. That happened to me this morning. Folks couldn't get out of my

driveway because the gate with the electronic gate was down. Because the power was down. Anyway, solve that problem. The way you describe it, my sense is that workouts will last somewhere between one and 2 hours of real work. Is that about right? It doesn't have to be nearly that long. I mean, you could certainly get enough work done in 30 minutes, even a whole body workout. Yeah, absolutely. So if you're doing that three days a week. So remember the numbers we're trying to hit here. Let's say we're trying to hit 15 working sets per muscle group per week. That's five working sets per day per muscle group. So if you did one exercise for that day, let's say you did squats, you did five sets, you did that three days a week. You're done. There's your 15. But there are other muscle groups to hit on the same day you're doing squats if you're doing a whole body. Yeah. So you've gotten them already. And so all the leg muscles in that example are taken care of. So you would not do separate hamstring work in a you wouldn't need to. Now, hamstrings is actually a little bit of a caveat. That's a good example of an exercise or a muscle group that's probably really good to make sure you isolate. It's challenging to get with your standard deadlift and squat. It's one of the probably ones that's most important to go target outside of that. But in theory, theoretically though, outside of that, you would get most of your leg muscles done with even a single exercise and even if you wanted to change it up. So you said, all right, Monday I'm going to do a squat variation. Wednesday, the next day lift, I'm going to do some sort of deadlift hinging variation. And then maybe Friday my third day, I'm going to do some sort of unilateral, maybe rear foot elevated split squat or something like that. All right. Maybe even a lateral lunge, maybe a different plane. Okay, you're in a pretty good spot. You're going to hit most of those muscles to your 15 working sets, especially if you take sort of that last set each day to pretty close to failure. That's going to get some more serious work done. But you're not going to be so fatigued. You can't come back and train it a couple of days later and you'll be fine. So you could even split that up into two days a week. And now all you really have to do is hit something like seven working sets. So maybe that's two exercises per day, maybe some sort of a leg press and a leg hinge. Three to four sets each. You're going to hit six to eight sets that day. You do that three days a week. Now all of a sudden you're at that 2024 sets. Badabing. A bit of boom. Same thing with the upper body. I just gave lower body examples because I like the lower body more. So it's not that challenging to get to those numbers and split. And those workouts can be extremely short. So if you were doing that three days a week, you're doing that one exercise upper body, one exercise lower body. That certainly shouldn't take more than 40 minutes. I'm happy to hear that. Not because I don't like training, please excuse the double negative, but I've found that resistance training workouts that extend longer than 1 hour of work and certainly longer than 75 minutes of work leave me very fatigued. Oh, sure. And fatigued to the point where concentrating

on cognitive work throughout the day can be challenging. Need a longer nap in the afternoon. I'm a big proponent of naps in the afternoon in any case, but requiring longer naps in the afternoon, et cetera. So at least for me, restricting the resistance training workouts to about 550 to 60 minutes of real work, for me, three or four times per week has helped tremendously. So it's a case where doing higher intensity work in a shorter period of time and actually hitting muscle groups less frequently, for me, that's, again, once directly, once indirectly has worked really well. And as you mentioned earlier, this could very well be explained by not my recovery quotient as some sort of genetic or physiological variable, but the way that I'm training. And indeed, I like to do a few four steps and go to failure on too many sets. And weaned in that genre of training. It's also fun. Like to just train hard. It is really fun. It is. I think that I've learned a lot by training, to quote unquote, to failure. Of course, I think there's a lot of learning in there, provided it's done safely. But what you're describing actually inspires me to at least give a try to these other sorts of splits and ways of training for hypertrophy and strength. Because this notion of not necessarily having to go to failure and still being able to evoke strength and hypertrophy adaptations is a really intriguing one, dare I even say a seductive one? And that leads me to a question that is based on findings that I've heard discussed on social media, which means very little, if anything, unless it's in the context of people who really know exercise science. And you're one such person. And that's this idea that because resistance

training can evoke a protein synthesis adaptation response, but that adaptation response lasts about 48 hours before it starts to taper off. That's the ideal. In quotes, frequency for training a given muscle group for hypertrophy is about every 48 hours. Is that true? Yes and no. So a couple of things there. Remember, in order to grow a muscle, there's multiple steps here. So you have the signaling response, which actually happens within seconds of exercise and can last, depending on the marker, up to an hour or 2 hours. Step number two then is gene expression, and we see that that's typically peaked around two to 6 hours post exercise. And then you have following that protein synthesis and that's that longer time frame somewhere between 12 hours there. It's certainly not peaked for 48 hours. It may be still there 48 hours from now, but it is absolutely coming down at that point depending on sort of a number of factors. So that part of it is sort of true. So this is a combination of some half truths and some maybe just pedantic things that aren't really that important to differentiate. The real question, I think, is like, okay, is it okay to train sooner? Is it better to train sooner? Or actually, is it better to wait longer? There's no real reason to think that you need to train if the goal is hypertrophy any sooner than 48 hours afterwards. I can't think of an advantage that that would confer. I also can't think of any practical applications, athletes, physique, bodybuilders coaches that ever found tremendous success doing that. So I would be very skeptical that that is any way better. Now, could you do it in some instances of, say, you've got travel coming up like that so that you just yeah, you want to preload the system by destroying the muscle. No problem. And then waiting seven days or 14 days. I've known people have done that before. I do it. Or layoffs every time, like every single to annihilate themselves and then take a two week layoff. Yeah. And it's like there's no benefit there other than psychological. I just love it. It feels great to be super sore. I feel less crappy not training for those couple of days because I'm like, I'm super sore anyway. You need the extended rest. Yeah, of course. And it's just like it's just a crappy justification in my brain, that excuse to do something really wild and that I totally don't need and get way sore than I should get. Dr. Andy Galvin's suggestions of what not to do, but that he does. Yeah, 100%. Do as I say, not as I do. The famous words of every research professor. Yeah. I think 48 hours is a reasonable time to wait. Can't think of any advantage of going sooner than that. There's really not a tremendous amount of advantage of waiting much longer than that. Certainly 72 hours is fine as long as you're hitting these concepts we've talked about. You can let reality determine that. I mean, there's situations too, particularly our athletes where we have to kind of break that because of schedule obligations. They're playing every fifth day, every third day, or something like that. And you're just going to have to lift on back to back days. You're just going to have to get it done. But, yeah, I can't think of why I would go out of my way to do that. The second part of that question is, let's say somebody trains a muscle. They train it properly, they hit it in the appropriate rep ranges and appropriate rest, et cetera. The stimulus is there, the adaptation is set in motion. They're getting somewhere at 48 hours or so, a protein synthesis peak that's going to taper off. But they don't train it 48 hours later or 72 hours later. They train it five or six days later, not because they're lazy, not because they don't care, but because they have other priorities that are woven in with getting hypertrophy in this muscle. There are people who exist only to get hypertrophy in a given muscle group. But let's be fair, most people would like to grow that muscle group. But then does it necessarily mean that the muscle starts to revert to its pre hypertrophic state? That is, does it atrophy and get smaller again? Because if it doesn't, I could see a lot of reasons for hitting a muscle group once every five days or seven days, provided you hold on to the hypertrophy that you initiated five or seven days ago. Yeah, there's no reason to think you will lose anything in that sort of a time domain, five to seven days. The only challenge with training that infrequently is can you actually get enough total volume done? So if you're going to train a muscle once a week, you either have to go to real failure, real damage and soreness, or you have to figure out a way to hit 20 sets that day in that muscle. Not at all impossible, especially if you're thinking, well, actually, all I have to get is 15 and I'm going to do five sets of three exercises. That's not outrageous. Not at all. Absolutely possible. If you're wanting to go more towards 20, we're

getting closer to that 25 now. It starts to get pretty challenging. So scientifically, the research will suggest it's going to be equally effective. Practically, it's challenging for people to hit sufficient volume without just being so demoralized afterwards because they're in so much pain, they can't get out of their car because their legs are so trash they can't sit on the toilet and get back up without crying from pain. That's not good. No, that's not good. I say that because those are actual examples that have happened in my life. Yeah, I'm realizing as we're having this conversation about ways to stimulate hypertrophy that I've sort of defaulted to more intensity as opposed to volume because of the time factor. I have a lot of other things going on in my life. And so within that hour, I can't get enough sets in across all the muscle groups I need to hit, and I'm only going to do it about once a week. And so it's at least for me, more advantageous to just train extremely hard. I actually use the pre exhaustion technique that you mentioned before, or pre fatigue, as you referred to it, of hitting something really strong with an isolation exercise, then doing compound exercises. I'm starting to think, based on what you've told me, that pre fatigue and then a compound exercise, in some ways it's not really two sets, because if you're going to failure force reps, you're kind of pushing past failure, then you're doing a compound exercise and you're doing that two or three times. Well, that sounds like four to six sets, but the force repetitions are almost like an additional set, right? Yes. And so it's not 20 sets, but it's four to six really hard sets that go beyond what we normally think of as a set. Totally. Okay. It's sort of the difference between running on concrete and running on sand. When I go for a sand run, it's a very different experience. Totally, yes. And this is why I should have mentioned this at the very, very beginning of our chat today, but all of these numbers that I'll give you for any exercise adaptation, you cannot think of them as hard lines, they are gradients. And so when we think about the number for hypertrophy in terms of repetitions, I said four to 30, what do you think happens at three? Do you think hypertrophy just stops? In fact, the number you'll see in literature is more like six to 30. I actually slide it down to four, though, like personal preference because of that, but it just fades away. What do you think happens at rep? 31, 35? It just fades gradually over time. So you actually sort of brought this up, one of your earlier questions, and I'm not sure if you were even thinking about this, or maybe you were, I just babbled on about something else. But if strength happens between this, like one to five repetition range, and hypertrophy typically happens in this like eight to 30 range, what happens if I were to do to sets of six or God forbid, seven, like seven and nine? Are these numbers you just absolutely don't do in strength training, right? Just like sets of 123456, got 810, twelve, like, do not program a set of 30. Now, when I'm trained sets of seven to nine, it's great, right? We'll use sets of seven a lot with weightlifters

because you can actually count numbers more effectively. But what happens in seven to nine rep ranges? So this is actually wonderful area of these, like five to eight repetitions, where you're going to get a nice combination of a lot of strength gains and a lot of hypertrophy. So someone who's coming in going, man, I want to get stronger and I want to add muscle. What do I do here? Well, that's actually a really nice answer. Train pretty hard in that like four to eight repetition range and you're going to get a lot stronger and you'll still induce a lot of hypertrophy. If you want to really maximize hypertrophy, I would probably spend most of your time in the eight to 15 repetition per set range. You can go up to 30. Admittedly, though, I don't think it's optimal to spend most of your time at more than 15 reps per set. It's very challenging to maintain the focus required at rep 27 to actually get sufficient failure. By rep 30, you just give up way too early. It's hard to do the same thing at the bottom end of that spectrum in terms of really heavy to get there. So I really, honestly think eight to 15 is still it's cliché. It's that textbook number. But that's a reason that's a textbook. It is tried and true and very, very effective. If, for instance, you want to get stronger though, and not invoke a lot of hypertrophy, you have a couple of tricks you can pull. Number one, stay south of that five repetition range. You do sets of one sets of two, go as heavy as you can with appropriate considerations and stick within maybe even up to three reps per set. You start getting to four to five to six. Now you're going to start itching towards that hypertrophy range. So stay down there, do a lot

more total sets. So do a classic example would be something like eight sets of three, right? You're going to get a lot of practice. You're going to get 24 very high quality reps with a lot of rest in between. You go from there, you go to managing caloric intake, making sure your protein is still on point. You want to recover. But if your total calories aren't greater than ten to 15% above your maintenance needs, then you're not going to be able to put on a whole bunch of muscle mass because you just don't have the fuel for it. You can also then space your workouts out so that stimulus isn't coming extremely often. So if you do that thing a couple of times a week, it's not enough frequency in that signal. So remember, that signal has to be frequent or loud. You didn't make it super loud and now you're not making it super frequent. You can get very strong like that and put on very low amounts of hypertrophy if that's sort of the choice. So you told us a lot about volume and frequency and how that relates to protein synthesis and recovery to evoke the hypertrophy adaptation response. How should people think about systemic damage and recovery? Because obviously the nervous system and the way it interacts with the neuromuscular system is the site of all the action here or at least a lot of the action and the nervous system can in fact become fatigued. It has a great capacity, but the whole system that we're talking about can be worked to the extent that even if a muscle group like the biceps or the back is being allowed to rest while you're training legs and other muscle groups, that your whole neuromuscular system needs rest. How does one determine whether or not your entire body needs complete rest or low level active rest or exercise of a different kind? Yeah, sure. So I want to actually tackle this because we're on the topic of hypertrophy. I'm assuming that that's the goal in mind here. Yes, here I'm asking specifically within the context of hypertrophy. I realize that for other training goals, the answer to this question could be quite different. Yeah, okay. So we actually do this in a couple of different ways. Let's start local and work back to systemic, right? Because number one, what you're really concerned about is at the local muscle level is, am I going to create excessive damage? And I don't necessarily mean muscle damage here, I mean injury. Right. So the kind of rule of thumb we use is like three out of ten in terms of soreness. If you're more than three out of ten in terms of soreness, we're going to start asking questions. If you're higher than six out of ten, we're probably not training. This is subjective measure, total subjective measure, right. And you'll know very quickly, right, if you can barely graze your PEC with your fingertip and then you're like, oh, I don't care what you score that we're not training. There's just no damage. If you're three out of ten, if you're just like, oh, I'm kind of like a little bit stiff here, but once you get warmed up, you start feeling okay, you're probably okay to proceed there. So that is a very easy way to just think about soreness. You're going to be a little bit tight depending on your training frequency. Now zooming out to systemic. We use a whole host of things, so we actually have a whole host of biomarkers we use. You can get a lot of these from blood. So you can look at things like creatine kinase. That's the very common one marker of muscle damage. We'll actually look at LDH, we'll look at myoglobin. If you think about hemoglobin is the molecule that carries oxygen throughout your blood. The myoglobin is the part of that that's actually in muscle. So when muscle gets broken down, that gets leaked out and put in your blood. That's one of the markers actually that's going to be associated with things like Rhabdo, which is like, you're going to see your urine is purple, it's extremely dark because you've got so much muscle breakdown that happens and kidneys give a problem and you put a bunch of stuff in there. So we'll use those biomarkers. We'll actually also look. At probably a couple of things you're familiar with ALT and AST, these are excellent biomarkers of muscle breakdown. So if we are actually suspecting that this is a chronic problem, we're going to actually go and pull some blood. If it's just like, I'm super sore today, we're going to use that subjective marker. But if we're seeing this as constant, like, man, are we really pushing you way too much? Is there some sort of systemic problem? We're going to blood and we're going to look at all those different things. Now AST to ALT is really specific, and I don't want to take us too far off track here, but the ratio to those things is actually very important as well. So if you look at the AST to ALT ratio, typically the number we'll look at is like 1.67. As that ratio is like higher than that, you have a pretty high risk of muscle damage. But really between me and you and a few of these listeners, anytime we start

seeing AST outkick alt, we're immediately thinking as in the ratio being higher than one, we're immediately thinking like there's something happening muscle damage wise. So that's actually a sneaky good indicator of just total muscle mass because the vast majority of that's going to be in muscle. So those are actually some markers that we like a lot. If muscle damage is the thing we're concerned with, if we are more concerned with things like total training volume, systemic overload, then we may turn to something more like sleep. There's a lot of information we can actually glean from changes in sleep behavior and function. You could also look at things like HRV heart rate variability, which is a very classic marker and much more sensitive to changes with training than something like a resting heart rate, which is one thing you can actually do that's totally cost free. Just look at your changes. And any elevation resting heart rate over time, especially more than three to five consecutive days, is an indicator. But HRV is much more sensitive to things like training induced overload. So that's a quick version of stuff that we're going to pay attention to. The last one, I would add there is simply motivation. So if you're really training hard and you like training hard and you just cannot force yourself to go anymore, that in of itself can be a good indication of it's. Maybe not the day, maybe not the week. With all of these things you want to be careful about overreacting to a single day measure. Again, we need to look at at least a trend of more than three days. Honestly, I'm looking at more than five days. I'm going to pull back from that and think about what phase of training we're in, what part of the year we're in. Typically with our athletes, we're in season, preseason, postseason offseason, et cetera, to make our decisions about what we're going to do about it. Are we canning the entire workout? Are we doing a modified lower version, lower intensity? My default. Generally, if hypertrophy is the goal, remember, volume is the driver there. So if I can, can we get in? Can we go real light? Let's go to six out of ten RPE. So relative perceived exertion, maybe we'll reduce the range of motion, maybe we'll make it a little bit easier, maybe go to machines or instead of going a squat, we'll just do leg extension, something like that. But I want to still get enough volume in there that will keep you on target again, even going at 50%, not to high repetition, 50% for a set of ten, three sets. Just get a nice blood flow in there, get it in, get it out, aid in recovery and then move on and come back the next day. That's probably what I would do. Rather than canning the entire session. How do other forms of exercise combine with hypertrophy training? For instance, can I do cardiovascular training for two or three days per week, provided that cardiovascular training is of low enough intensity and not disrupt hypertrophy progression. And can I do that cardiovascular exercise before or after the hypertrophy training, or does it need to be separated out? The answer to this is really what we call the crossover interference

effect. It's really an energy management issue. So the only time endurance exercise starts to interfere or block or hinder attenuate hypertrophy is in one of two broad categories. Number one, total energy intake. Or your balance is off. So you can ameliorate this by just eating more. If you do that, then the interference effect generally goes away. The second one is you want to make sure you avoid exercise forms for your endurance training that are the same working group and specifically the eccentric portion. So for example, we see much more interference with running on lung hypertrophy than we do with cycling, right? Less eccentric, pounding and loading, less damage, less things to recover from. The tissue seems to be totally fine. The only other thing you need to worry about here is total volume of your endurance work. So if you're doing a moderate intensity for a moderate duration, say 70% of your maximum heart rate for 25 minutes, it's unlikely to do much damage. In terms of blocking hypertrophy, you're totally fine. Can you do it before or after your workout? It's probably not going to matter that much. So pre fatigue is okay for hypertrophy. So if your pre fatigue is coming from endurance, then you're totally fine. Not a big deal afterwards. Cool. You want to break it up into multiple sessions, that's probably better, right? So if you do your endurance work on a separate day, that's probably best case scenario. If you can't do that but you can break it up into two workouts. Say you lift in the morning and then you do your quote unquote cardio at night. Maybe that's second best, third best is doing it at the end of your lift and finishing it. That's fine. Just make sure that you're maximizing your recovery on all the other tricks we'll talk about later. Make

sure the calories are there, make sure you're not doing a lot of eccentric landing in that endurance stuff and you'll be just fine. And where does higher intensity cardio fit into a hypertrophy program? So higher intensity cardio, for instance, in my mind, is getting on the assault bike and doing eight intervals of 22nd sprints and ten second rest in between, or perhaps going to a field and doing some bounds and sprints and things of that sort. Not going all out, not running for one's life, but getting up to about 85, 90% of running for one's life. Sure. So we have a lot less information on the potential interference or not of high intensity stuff. The stuff we do have suggested, it may actually aid in hypertrophy, and that's because if you think about it, one of the potential paths to activation and muscle growth is this metabolic disturbance. You're going to get that a lot with the high intensity interval thing. So it's not a terrible thing to do. I wouldn't do it to the level that it compromises your ability to come back and do your primary training. So if you're so fatigued, your legs are super heavy, they're depleted, you now have to ingest extra carbohydrates to replenish muscle glycogen to be able to handle both recovery and continued training, et cetera. That could then lead to a problem. But in general, we really don't see any reason why that is going to completely block or make it such that your training was, quote unquote, wasted or it didn't work. In fact, actually a very recent study came out where they had individuals perform six weeks of purely aerobic endurance, steady state, long duration endurance for six weeks, I think prior to starting a hypertrophy phase, compared that to individuals who did not do that. And those folks that did these six weeks of just, I think it was cycling, actually just endurance work, had more muscle growth at the end of their hypertrophy training than those folks that did not. So this shows you very clearly there are a lot of advantages that come with being physically fit to growing muscle. So folks that also have actually hit plateaus a lot, one of the things you may actually see some benefit from is actually doing a little bit more endurance work. Whether it's the steady state stuff, maybe it's the higher intensity stuff. Certainly if you're starting a training phase, it's a pretty good idea to do that. And there's a number of physiological reasons of why that's potentially occurring. But the lowest hanging fruit here is we sort of joke if you're so unfit that you're tying your shoes in your warm up and you're already breaking a sweat, you probably don't have enough fitness to do enough training to get enough hypertrophy. So that is in fact your limiting factor. You're not recovering. You're super fatigued and damaged and sore because you're so unfit. So get fit first and then you can actually get more gains a week later. So you have to kind of kick the can down the road for a few weeks, but ten weeks later you'll be in a better spot than you were by investing a little bit in your conditioning. So, as you point out before, and I can only assume you're referring to me, hypertrophy training is idiot proof, meaning there's a lot of leeway in the variables, but not so much leeway that people can do anything. It's bounded by these general principles. So, with your permission, I'm going to do a brief overview of my notes based on your description of the modifiable variables that will direct somebody towards hypertrophy. Keeping in mind this backdrop of exercise choice exercise order selecting appropriate volume that sets in reps training frequency and needing some metric or way to have progression either by adding more weight or by more tension or more metabolic stress and so on. In terms of exercise choice. It sounds like the choice of exercises is not super critical in terms of specificity, but that the ideal circumstance is that people are targeting all the major and frankly, secondary and minor muscle groups. If you can even call. Them that across their exercise choices, that they're picking exercises that they can perform safely and that they can generate enough intensity so that they're getting close to failure without placing themselves into danger. Right? So for some people that might mean including large compound free weight exercises like squats and deadlifts and bent over barbell rows, as well as isolation exercises. And for some people there might be a bias toward more isolation exercises and machines. But of course, machines don't necessarily mean that you can't use heavy loads. In fact, plate loaded machines like Hammer strength machines will allow for quite substantial loads. So picking two or three or more movements per muscle group can be valuable. But that overall consistency is going to outshine variation in the sense that you don't need to hit muscles with a different exercise every workout. Coming back to the same

things has a benefit. And we heard about this in our discussion around strength and power as well. Okay, in terms of order of exercises there too, it sounds like there's a lot of flexibility. One could do the large compound exercise for, let's say, quadriceps and hamstrings and glutes first, like a squat or a front squat, or could deadlift for that matter. But then if one deadlifted and primarily hit the glutes and hamstrings, then you might want to target the quadriceps more directly with leg extensions. Or if one squatted and was loading the squat bar, carrying the squat bar in a way that was predominantly quadricep and less so glute and hamstring, then leg curls would be a good choice, et cetera. Okay. And train your calves, folks. Very important. Unless you're a genetic freak, of course. That's actually a good opportunity to say unless you're a genetic freak, or you just have a genetic predisposition, or you've done sports and you have a genetic predisposition that gives you very large calves that don't require any training at all. I know people like this. They're somewhat rare, but they're out there. And those folks sometimes want to stay away from or minimize their training. You told me that even if you have a muscle group that's a hyper responder, in terms of hypertrophy, getting at least one or two good hard sets per week is good because you want to keep functionality in that neuromuscular system. Love it. Okay. In terms of volume, again, we have a large amount of variation, is what I'm hearing, that the total number of sets per week is a strong driving force of program design and selection. That ideally, you're performing ten to 20 and probably more like 15 to 20 sets per week. And that could be divided up across multiple workouts or done in one workout, but that's ten to 20 sets per week per muscle group, not really taking into account indirect activation. So that would be ten to 20 sets, four biceps. Your back work is going to hit your biceps a little bit, maybe a bit more, depending on the exercise selection, but it's really ten to 20. And given that hypertrophy can still occur and maybe even occurs better with more volume, then don't include the indirect work unless something about the architecture of your body and the inability to engage certain muscle groups makes a pull up really an arm exercise for you. Do I have that right? The way that I would maybe define it is typically with movements we consider to be there to be primary movers, secondary movers, and then tertiary movers. Right. If it is a primary or a secondary, I'm probably counting it. If it's tertiary or less, I'm probably not counting it. Got it. So going back to our example of a pull up so, an example of a pull up, I probably wouldn't count the biceps in a pull up, but I would probably count the biceps during a chin up. Would you count the rear deltoid in a pull up? Probably not. Maybe it just depends. Probably not, though. Okay, train the rear delts only. Honestly, the reason I answered that is because most people don't do anything for the real delts anyways. But they should, right? Absolutely. That's why

I didn't want to count it. I wanted you to go out of your way to make sure you did something specifically for the real rear delts, for aesthetics and for functionality, for health and balance across the shoulders, totally. Neck, shoulder, all of it. I'm so happy to hear you say this. I'm a huge fan of people doing rear deltoid work for all the reasons you described, and neck work for that matter. I think people forget that the neck is the upper part of your spine, and for postural reasons and for stabilization and safety reasons, it's really critical. But I think most people aren't familiar with how best to train the rear deltoids and neck. And I know a number of people are afraid of getting a big neck, which for reasons that are still unclear to me, is referred to as no neck. But let's leave out that no neck comment for the moment. What are some good exercises for targeting the rear deltoids and neck safely that people can perform for stabilization and for hypertrophy? I would recommend people check out Eric Cressy. He is a wonderful strength conditioning coach. He actually is, I think, the director of pitching for the New York Yankees. Now, is that spelled C-R-E-S-S-I-E-C-R-E-S-S-E-Y-I believe. And he's got a facility in, I believe, Boston, as well as in Florida. So he's very involved in pitching as well as hockey and things like that. So he has so many free videos and resources on so much of the shoulder girdle, mostly because he's dealt with overhead and throwing athletes, and so the precision required there is tremendous. So you want to be very careful when you start playing in this area because the wrong positioning of your scapula can cause a whole bunch of problems in your neck and low back. And so he would be a great resource to go take a look at that.

Depending on how your scapulas are gliding and sliding and the way that you want your rotator cuffs firing, your Rhomboids, it gets very complicated very quickly. So you want to learn more, go there as a very quick couple of answers. One of my favorite exercises is lying on a bench or putting some bench and then just doing a reverse fly. Basically, the reason I like stabilizing the rest of the body is so you can make sure you can focus on just using those rear Doyle toys and putting your scapulas in the right position. Now, there's a specific set of queuing that you want the scapula to move down and back for. Again, check out Eric or any number of folks in that area to do it, but that's a very simple way, the reverse flight to get there. Great. And then in terms of neck exercises, I was told to avoid bridges because they can cause damage to the discs. I will probably never do a bridge ever, the rest of my life. So isometrics are a great exercise for that because if you think about what you're asking muscle groups to do in the neck, you mostly want it to be able to do a certain type of rotation, a little bit of flexion extension and some other movements. But in general it should be being stable. So you want to walk through these joints asking kind of what they do. Are they a moving joint or they a stability joint? In this case, you want it through there. So isometrics are going to put you in a much better position. There are some actually pretty cool devices that you can wear, and you could put them on your head and you can do all kinds of movement and get some great training there. Those are great starts, but if you don't have any of that, just basic isometrics are a great way to go about it. Neck bridges would not be on that list for me. No neck bridges, folks. In terms of sets and repetitions, we briefly touched on this, but anywhere from, I believe, six repetitions all the way up to 30 repetitions, but probably more in the eight to 15 repetition range for hypertrophy most of the time, yeah. And I'll just throw in there because I love this idea that if you want to get a relatively balanced adaptation related to strength and hypertrophy, that seven to nine range, the no man's or no woman's land of training repetitions. I always joke in class, I'm like, okay, we go through the whole thing, right? You're like, one to five strength, eight to twelve hypertrophy, and you're like, Great. And then I'm like, okay, so six to nine means nothing will happen at all. The kids are just like writing it down, right? A good way for everybody to remember that there are adaptations triggered in the six to nine rep range, and it's a balance of strength and height. You'll just get thrown out of any gym that I'm a part of. Fantastic if you do that. But the important point is to get close to failure and occasionally hit failure, maybe occasionally throw in a forced repetition or a rest pause where you rest and then do a few more, something like that. But those intensity increasing maneuvers will require a little bit more attention to recovery either time, or attention in some other way. And here's a little bit of carrot I'll throw at people, because people generally don't like to be told to not go to failure that often, right? So there's a handful. Half the folks are like, sweet, I don't have to train that hard to get there. And those folks, it's like, well, yes, but I also said you just can't do a half workout. You have to get pretty darn close to failure. And most people don't really know what failure means. So for that group, it's still probably harder than you think you want to train. For the other group, though, that wants to completely blow themselves out every single time. Dragging them back is more the key. Now for those folks, here's what I can say. If you make sure that your hidden stressors, invisible stressors, are completely taken care of, you can go to failure a lot more often. And so you need to dial those things in. And then now you can go hammer yourself because you'll recover so much quicker. And we see this very commonly in all of our programs with our athletes and our non athletes, that when we get the rest of the hidden, invisible stressors taken care of, their training volume goes up so much because they'll just start coming back and then it's like, oh my God, I'm not sore anymore. Oh my God, I'm not nearly as sore. I did this exact workout countless times before and now I'm doing it and I'm not sore at all anymore. What the hell? We didn't do anything different with the programming or really the nutrition, but we got the rest of that allostatic load under control and boom, things take off. It's a lot like drivers. So many people seem to be riding the brake and so many people seem to be heavy on the accelerator. Yeah, that's actually one of the ways we describe it. It's like you want to go faster people's inclination. Step one is to hit the gas. Our step number one is making

sure your left foot's not on the brake. You'll go faster with less resistance, which means you'll actually wear down the system a lot slower by just taking your foot off the brake first. If you're then not going fast enough, now we can push the accelerator, but I'm not pushing that accelerator. While your foot's still on the brake. You're going to go a little bit faster, but not as fast as you should be going with that much work. And you're going to start wearing down brake pedals and things like that. I like that analogy. It so hitting that ten to 20 sets per week repetition range is pretty broad, provided you get close to failure. Hit failure every once in a while could be the final set of each exercise. Or maybe do one workout where you hit failure on everything, but then you don't do it for a few more. Again, it sounds like there's a lot of play in the system here. Rest ranges anywhere from 30 seconds all the way up to three or four minutes, depending on how heavy you're training and how close to failure, or to failure. Maybe even, quote unquote, beyond failure, if there is such a thing. You're training throwing in negatives and things like that. We didn't get into really high intensity techniques, but people again vary in the extent to which they're pushing the system. But there does seem to be some value to mixing up the rest between set ranges, across exercises and across workouts. But you could combine them all in the same workout is what I heard. And then in terms of progression, it sounds to me like the goal in hypertrophy training is not necessarily to add more weight to the bar, although that's one way one could do it, but that the progression actually can. Arrive through this really extensive kit of changing the speed of movement, changing the number of sets, adding some volume, maybe changing the split, so that you go from a three day a week full body workout to more of a body parts. One or two body parts per day, every other day or two on one off any number of different variations that are out there. Sounds like all of these can and will work, provided that people are obeying the general principles of this hypertrophy adaptation inducing protocol that you described and that they are meeting the necessary but not sufficient variables as well, such as sleep, nutrition, and managing the stress in the rest of their life. Do I have that correctly? Yeah, that's really good. One more thing I'd like to add is this is a situation for hypertrophy in which there are some exercises that I actually don't think are good ideas. So I want to make sure we included those in the conversation. That's not necessarily the case. For strength, you can really do kind of whatever one you want, and that is specifically plyometrics. Although in fact, if you look at there's, a recent review paper came out showing that plyometrics are effective as well for hypertrophy. Like one can do almost anything as long as it falls within this parameter set. The concepts are few and the methods are many. And the methods for hypertrophy are many. Many. In general, though, plyometrics are not my 1st, 2nd or even

like hundredth choice for hypertrophy if they're a part of a total training program and you get some hypertrophy as a result. Cool. You're lucky. Not the first place I'm going. The other major category are weightlifting variations. So that when I'm saying weightlifting, I mean specifically Olympic weightlifting, as in snatch, clean and jerk. And their variations, those are just not a good exercise choice. It's not that they don't work, it's just the risk to benefit ratio starts to fall pretty fast in the negative favor. And so it's just not worth doing sets of ten of a snatch unless you're in a sport where that's like the competition or whatever. But if the goal is simply hypertrophy, choose different exercises than that. Great. Now, I realize that we are going to do entire episodes related to nutrition, supplementation, recovery, et cetera, but I'd like to just touch on two or three specific topics and questions that come up a lot around the question of hypertrophy specifically, and that probably also relate to strength training and training for speed. So I'm going to ask these in not rapid fire, sure, but I'll give you shorter answers, we'll put it that way. So I will ask these questions now, but with the caveat that we will get into these topics in much more depth very soon. The first question is about the use of cold showers and ice baths and cold water exposure, which I know many people use for resilience training. To increase their dopamine, which it does, and for recovery. But there's also this issue of when one should use cold, that is deliberate cold exposure relative to hypertrophy training specifically. And that's because I've heard that if deliberate cold exposure is done too soon after a hypertrophy adaptation inducing workout, all the sorts of things we've

been talking about, that the hypertrophy response can be blunted reduced or eliminated. Is that true? And if so, when could people do deliberate cold exposure while still also including hypertrophy training in their program and still get hypertrophy? Great. So, you know, I'm a lover of the cold. I still have a deep freezer in my house that is filled with water at all times that I've plugged in and is a frozen chamber. I still do the old school style of it. Please unplug it before you get in it each. Oh yes, absolutely. And then don't do it by yourself so that the lid can close on top of you and then we don't see you sort of ever again. The Han Solo Effect it's time for me to upgrade one of these new fancy ones. But I've been using this for so many years, so I love it. Obviously I've been involved with XPT and Gabby and Laird and Brian Mackenzie and these folks, so I've been doing this stuff for a long time, I don't even know how many hundreds of folks into the ice and done them for a lot of reasons. So there are a lot of benefits and we could talk about those later. However, that being said, it is very, very true. You do not want to get in the ice post hypertrophy training. You wouldn't want to do that immediately after the workout. You probably don't want to do it before the workout, and you probably don't even want to do it that same day. It's just not worth it. It will blunt hypertrophy. And specifically we've talked earlier about what's driving muscle growth is that signaling cascade through that gene expression through that muscle protein synthesis. Cold exposure blocks that signal. Remember, adaptation comes from stress. You've put in a stressor in now you've blocked that stress. You've literally blocked the signal that tells your body, come back and grow larger size. So not a good idea to do it if you're training for some other purposes. Maybe strength, maybe there's an argument there, although maybe not for speed and power. Maybe you can get away with it. Endurance may be a separate conversation. If you're in season, I have no problem using it immediately after a game. The goal is entirely different. Even if we did a hypertrophy type of training program, we're not doing it to try to maximize growth. In that particular case, our priority for recovery is higher than our priority for muscle growth. So we choose optimization in that category. You can only make those choices, though, when you truly understand what is the goal for the. Day, the week, the month, the phase of training, and really what part of the year you're in. We have that all plotted out for all the people we work with. So I know when we want to choose one over the other, it's not a this is the choice you always make situation. That's just not how we operate. We need more precision than that. So that being said, we're generally not going to do it. If we want to do a lot of Icing during a phase in which we're using a lot of hypertrophy, we're going to do a couple of things. Number one, we may just not use it. So there are phases in our training where I don't want to maximize recovery. I'm not going to give you any tricks here. I'm not going to do ice or any of the other methods. We're going to talk about why, because the whole point is to cause overload. That's what's going to be the stimuli to cause adaptation. If all I'm doing is blocking that stuff attenuating it, smashing it back down, I'm undercutting myself. I'm choosing to feel a little bit better, to have a little bit better performance right now, knowing that's going to compromise the results. I'm going to get 6810 twelve weeks from now. So I'm not going to choose it at all. In the reality of it is if I really am trying to maximize hypertrophy, I'm probably not doing any ice work during that whole phase. Maybe like my off day. I know that's similar to a setup. You have like one day a week when I'm not training. We'll jump in some ice, maybe even do some hot cold contrast. I love the XPT protocol. You've probably talked about it before. That's a great setup. Or just not do it at all, right? It's just not something we need when we move into another phase of training where we're trying to maximize adaptation or maximize the result and get the benefit of that training. Now we're going to hedge more towards recovery and we're going to bring in some of these strategies and techniques and not worry about causing the most stimuli there because we're trying to attenuate because we're trying to actualize the work we did 6810 twelve weeks before. What about cold showers? Do those have the same hypertrophy blunting effect in general? No. In general you can do cold showers. That's not going to be a problem. You're not going to be in there very long, and you're not going to get nearly as cold as you will submerged in 30 degree ice water the way that we do it, nonetheless. So I have no problem standing in the shower for a couple of minutes using it for other reasons if you

want to. That's no issue. I'd like to talk a little bit about nutrition and supplementation as it relates to hypertrophy. Dr. Lane Norton, who's been a guest on the Huberman Lab podcast and we both know, throughout a number range related to protein intake, on the backdrop of how much protein synthesis can occur by meal, across the day, et cetera. A lot of research done there and some important work by him in particular. And then the value that he threw out was 1.6 grams/kg of body weight being the lower end of the range up to I believe it was as high as 2.4, maybe even as high as 2.7 grams of protein per kilogram of body weight per day. That's a pretty broad range. But it's on the higher end of what I think most people think of in terms of protein intake. And then again, some people might already be right there or maybe even above that value. Of course, this all depends on whether or not people are omnivore, vegan, meat based, et cetera. We won't even go there. But assuming people are getting enough protein per day. So somewhere in that range and they are spreading out that protein intake to accommodate the fact that the body can only assimilate a certain amount of protein in any given sitting, what do you like to see people ingest at some point? Post hypertrophy inducing workout in order to get the protein synthesis advantage, if you will, that is stimulated by that workout? Earlier you mentioned the post training feeding window that in the probably earlier people were talking about, oh, within the first 90 minutes, you have to get, was it 30 minutes of a certain number of grams of carbohydrate and protein, et cetera. I think now the understanding is that window is much broader and how broad, et cetera, is still a matter of debate. But when somebody is training specifically for hypertrophy, assuming they are getting enough protein from quality sources in their other meals, and assuming that their overall macronutrient intake and caloric intake is high enough, that is, they have enough of a caloric surplus that they have the raw materials for hypertrophy. What do you like to see people ingest at some point post workout in order to facilitate muscle protein synthesis and recovery? And this could include nutrition and supplementation. Or if you want to divide those answers out, feel free to do so, of course. Yeah. Okay, great. So a ton of work came out of Don Layman's label. It's actually Lane's Mentor as well as Stu Phillips at McMaster. So a ton of work there. And we can answer a number of things here. So Lane's numbers that he recommended, also known as about a gram of protein per pound of body weight, it's a great start. Now, once you slide below that's per pound, right? 1 gram per pound, right. And earlier, which is also to make sure because we're changing units here, it was 1.6 grams/kg of body weight all the way up to I think it was 2.4, but maybe as high as 2.7 grams of protein per kilogram of body weight. So 2.2 in that unit would be the same thing. So 2.2 grams/kg is the same as 1 gram per pound, right? So depending on which where you're listening at to this

at, one of those may be easier than the other for you if you start getting below that number. Now, you do start running into questions of protein quality, protein type and protein timing. This is one of the reasons why I actually fully agree with Lane, is just get that number higher than you think and then all those other variables don't matter. If that number is low, then you need to start paying attention to a bunch of other stuff you've added. Now, complexity to your program, things you got to pay attention to, just stay high and yet it doesn't matter. And so you can just leave a lot of those things off the table. That seems to be fairly clear in the work of some of these gentlemen. I just mentioned that as long as you get to that total number, the question about timing and types and quality, it seems to matter a lot less. In fact, Sue's recent work in non animal based proteins really showed that to be fairly clear, that those are quite effective. Assuming total protein intake is high enough, the amount of leucine and other amino acids in those actual proteins matter less if the total threshold is just super high. So just do that and you're fine. Now, the other caveat we have to say here is timing of macronutrients seems to be somewhat irrelevant for protein, but that is not the case for carbohydrates. So that timing does matter. Replenishment of muscle glycogen is very specific and you want to make sure that that is around a lot if you're doing either maintaining training quality or you're sliding into endurance type of work. And so nutrient timing does matter with carbohydrates. Maybe less so with protein and certainly less so with protein if the total protein ingestion is high enough. So it depends on what we're going after in terms of a training goal and

where we want to get with all these things. In general. The way that we like to think about this is if you're doing a strength type of work where you're truly targeting that, then a one to one post exercise, protein to carbohydrate ratio is generally what we're going to go after. So this would be something like 35 grams of protein, 35 grams of carbohydrate. It doesn't have to be post, it can be pre or my favorite is actually mid or post, but somewhere in that range, especially if you're training in the morning and you have not consumed anything prior to your workout. And that's not necessarily eating in the middle of the workout, that's drinking calories. I have to see someone eating a sandwich in the gym, although I'm sure it's happened. So one to one is that sort of standard number here? If you're going to do sort of more of a really hard conditioning workout. That number slides up to something like three or even four to one, which would be carbohydrate to protein ratio. So if we want to stay at 35 grams of protein, we're going to go maybe as high as like 100 or 140 grams of carbohydrate. Again, depending on what type of training we're sort of doing. If you're going to do a little bit of a combination then like a little bit of strength, a little bit of conditioning and kind of a standard workout, which is probably something that a lot of people will do, then you maybe want to go to something like two to one. So 35 grams of protein, 60, 70 grams of carbohydrate, and those are kind of just like rough numbers that you can go by. And for pure hypertrophy training, would you like to see people ingest some carbohydrate post training? For pure hypertrophy training, I want to see that as many of those nutrients around the training as generally possible. Now again, I may change my mind when our fasting study comes out, but as it stands now, there is no advantage to not fueling around the training and there are some known and some other potential advantages to fueling. So I just see no reason to not do it. In fact, most people are generally going to do better. Now, this is not science, this is just my coaching experience and this is with our athletes and all of our non athletes that we've worked with and do work with. They're just going to be better spreading those meals out generally throughout the day. And they're going to be better if they have those nutrients either pre, mid or post. And so they're going to get even for hypertrophy, they're going to get something like that. One three to one ratio of carbs to protein. Personal preference. Some people don't like to eat before they train. Some people have to eat before they train. Some people can't put in food in their belly immediately after work around that you can play based on personal preference. But we want that fueling in there because we want to maximize the potential growth and we want to just get a jump start on recovery because we're going to be training again pretty soon. Supplementation is a huge topic and one that we will go into in great depth in a soon to occur episode. But if you had to pick one supplement that can benefit most everybody, if not everybody, for their training directed toward strength, power and hypertrophy, what would that supplement be and how would you like to see people use it? Meaning how much should they take and when should they take it? Sure, if you don't count protein and carbohydrates as supplements, they technically are, but we'll just walk out of that, right? Sorry, I should be more specific. I'm not referring to non food form protein and carbohydrate. So powdered protein and powdered, carbohydrate, et cetera, technically are supplements. They're highly processed, but I'm not including that. I'm referring to non macronutrient type supplements. Yeah. Does testosterone count? Well, in the context of this discussion, it's testosterone that people are manufacturing themselves. Okay. The cheating kind, the endogenous kind. No, I mean, Creatine is the answer here. Without question. It is the most well studied, it is the most effective, and its benefits are robust, meaning they are going to confer positive adaptations across multiple physiological domains. We could certainly have a very long chat about some of the interesting things that people in fact, we just had Darren Candow on our Barbara Shrugged podcast, and he went into extensive detail about all the benefits of Creatine that people have no idea about, including things like bone mineral density. You asked about that earlier. Creatine is actually fairly effective for that, let alone the benefit in things like cognitive function, decision making, memory, the work that there's being done there for neurological disorders, depression, a whole host of things that Creatine is being studied for. Some of those studies show a lot of benefits. Some of it show maybe a little bit, some none. But there's just a lot of things Creatine can do. So when we could talk about muscle recovery or muscle

hypertrophy, that's where the bulk of the research is. And it's very effective in terms of type. Creatine monohydrate is still the best one, and that's just because it has the largest evidence base. You can maybe make some arguments for some other types, but you're really going to reach saturation pretty quickly within a matter of weeks. And there at a dosage of anywhere between like three to 6 grams per day. Now, 5 grams is the very standard number we give. Reality is, I change that number based on size. That's just the honest truth. If you're 225 pounds, you're not going to get the same dosage of Creatine as 125 pound girl. This is not what we're going to do. So we may slide that number down a little bit closer to three for the smaller girl, boy doesn't matter. It's just physical size. If you're one of our 275 or 330 pound offensive right tackles in the NFL, you're not going to get the same dosage as everybody else. So that number is going to go up to seven, eight, nine, maybe even 10 grams a day. So that's just kind of the scale in general. If you wanted an easy answer, 5 grams is the standard taken after training. The timing doesn't matter, totally irrelevant. Take it in the morning, breakfast, take it at night, take it anytime you want. Take it pre. We tend to put it in a lot of people's workout shakes just to make sure they get it in throughout the day, but the timing is irrelevant. Great. Well, thank you for that very informative answer, and I look forward to much more discussion about nutrition and supplementation and recovery and all the rest in the episodes to come. This was incredibly informative. Thank you so very much. I appreciate the opportunity. I had a great time doing that. I love talking about these things. I also really like talking about what we're going to get into in our next conversation, which is the physiology of endurance, metabolism and fat loss. 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. In addition, please subscribe to the podcast on Spotify and Apple, and on both Spotify and Apple, you can leave us up to a five star review. If you have questions for us, or comments or suggestions about topics you'd like us to cover or guests you'd like me to include on the Huberman Lab podcast, please put those in the comments section on YouTube. We do read all the comments. Please also check out the sponsors mentioned at the beginning and during today's episode. That's the best way to support this podcast. I'd also like to inform you about the Huberman Lab podcast free newsletter. It's called the Neural Network Newsletter, and each month the Neural Network newsletter is sent out and it contains summaries of podcast episodes, specific protocols discussed on the Huberman Lab podcast, all in fairly concise format, and all completely zero cost. You can sign up for the Neural Network Newsletter by going to [Hubermanlab.com](https://hubermanlab.com), go to the menu and click on Newsletter. You provide us your email. We do not share it with anybody, and as I mentioned before, it's completely zero cost. By going to [Hubermanlab.com](https://hubermanlab.com), you can also go into the Menu tab and go to newsletter and see some example newsletters from months past. Thank you once again for joining me for today's discussion about fitness, exercise and performance with Dr. Andy Galpin. And as always, thank you for your interest in science.