DANNY LENNON: I think we should all be familiar with the fact that sleep quantity and quality are important aspects of both health and performance, and we've touched on this several times on this particular show before. But when it comes to sleep quality there's various different aspects we can look at this from. One way to examine the quality of sleep that we get is to look at sleep architecture. So this essentially refers to that structural organization of different stages of sleep that we move through throughout the night and trying to evaluate what should those stages look like, how long should we be in them, how do we move through them, and what things can we do to promote let's say "good sleep architecture" and certainly what things should we be avoiding that would disrupt what our sleep architecture should ideally look like.

These are some interesting questions we're hoping to explore in today's episode alongside looking at inter individual variation within chronotypes, how that has implications for training and lifestyle schedules as well as what tactics and interventions can we use to potentially rescue some performance both cognitive and athletic in cases where we're going to have some disruption or at least some

barriers. So all of that is going to be discussed in this episode of Sigma Nutrition Radio.

So we are at episode 312 of the podcast and as always I am your host Danny Lennon. Today's guest is Dr. Allison Brager who is a behavioral neurobiologist with an expertise in sleep and circadian rhythms for the United States Army [00:01:50] as well as the contributions of sleep and circadian rhythms in psychiatric, neurological and inflammatory disease states. Currently she's the director of human performance operations at the U.S. Army Warrior Fitness Training Center in Fort Knox, Kentucky and previously she was a postdoc fellow at Morehouse School of Medicine in Atlanta, Georgia, as well as being the chief of the sleep research center at the Walter Reed Army Institute of Research and her work has examined sleep and activity regulatory mechanisms as well as adaptation and resiliency to environmental stressors such as jet lag and sleep deprivation.

If you want to get the show notes this episode, they're over at sigmanutrition.com/episode312. You'll be able to get a transcript to this episode. You will be able to get links to anything relevant we mentioned as well as anything else interesting that's related to our topic today or that you might find a value. So with that, let's jump into this conversation and in a moment you are going to hear my conversation with Dr Allison Brager.

Before we get into today's episode, let me give a quick mention to today's show sponsor Legion Athletics. Legion Athletics are a supplement company that I've actually been involved with for a while now as a member of their scientific advisory board alongside several other reputable people who you're probably familiar with and I agreed to do so because it was clear how much importance the company placed on having evidence based decisions and ethical marketing at the center of their plans. So Legion have full transparency over the

ingredients in their products with no proprietary blends used and peer reviewed research cited for each product. And one of the cool aspects is that the company asked those of us on the scientific advisory board for independent input on the potential effect, newness and evidence strength of different products, ingredients set they are considering or using. And that means importantly that all the ingredients included are dose at the clinically effective levels actually seen in research. There's no overhyping of products or even the value of supplements in general and if there are no misleading claims about what they may do. If you're interested in trying any of the Legion supplement line, then you can go over to buylegion.com and if you use the coupon code SIGMA, that's Sigma in all caps, you will get 20% off your first purchase. If you're in the U.S. you get free shipping on any order and then for all other international customers, you get free shipping on any order over $99 and all of those orders comes with a 100% money back guarantee. So if you want to try that stuff out, or even just take a look at the product line, just go to buylegion.com and use the coupon code SIGMA.

So here we are. Allison thank you so much for joining me on the podcast.

ALLISON BRAGER: Of course. It's great to be on.

DANNY LENNON: Yes, I have so much that I want to ask you about. But before I get into any of my own specific questions, I'm quite intrigued to hear a bit more about your background as well as the current work that you're doing because a lot of it is fascinating to me looking from the outside of trying to get a grips of what you typically do. So can you maybe give us an explanation of some of overview of your backgrounds particularly as it pertains to the type of work you're doing right now, and an idea of what your role looks like?

ALLISON BRAGER: Yeah, sure. So I am a neuroscientist by training. I specialize in sleep and circadian

rhythms research which basically means that I'm looking for new brain areas, new connections between brain areas as well as the chemical systems that control these brain areas and how they relate to sleep. My research is very applied and that I take this basic discovery about sleep and then try to translate it over to real world problems. Mostly looking at how humans can survive in very extreme conditions under high levels of stress, high levels of sleep deprivation how do we take the system and how do we keep the system functioning despite external factors keeping the system from being at its best.

DANNY LENNON: Super cool. And we're definitely going to dig into some of those specifics hopefully during this conversation. I thought a good place to start when we get into any of these discussions around sleep would be to talk a bit about sleep architecture. And I think most people will be familiar that we have these different stages of sleep, but maybe not so clear on some of the specifics or what exactly those stages or typical sleep cycle should look like. So can you maybe explain some of that around sleep architecture, those stages of sleep and what we would want to see ideally?

ALLISON BRAGER: Sure. So there are four distinctive stages of sleep and these stages oscillate on a roughly 90 minutes sleep cycle. So throughout the night we constantly transition in and out of these stages. The first three stages are comprised of what we call non rapid eye movement sleep or non-REM sleep for short. And stage one is the lightest stage of sleep. So that's usually what you transition into sleep into is stage one. And then you eventually reach a stage three sleep, which is the most critical stage of sleep, not just for athletes but for anyone because this is the stage of sleep for all the recovery and repair actions going on in the body of which sleep is necessary for our occurring. So this is where you have the release of anabolic hormones. This is where toxic free radicals are cleared from the brain and in sort of a muscle repair,

muscle recovery process is also occurring during the stage three deep sleep.

Now, the fourth stage of sleep stands alone. It's a Rapid Eye Movement sleep or REM sleep for short and this is the stage of sleep in which you exclusively dream and REM sleep is absolutely critical for learning and memory. There's plenty of studies now that have been done to show that if you deprive somebody of REM sleep or this individual doesn't get adequate REM sleep then they have a very difficult time learning a new task or repeating a task that they learned recently because all of those connections that are necessary to learn something new occur exclusively during REM sleep.

Now what's really unique about the sleep cycle is the body and the brain partition the first three stages of sleep. So non-REM sleep within the first half of the night. So typically within that 90 minute sleep cycle, you'll see more episodes of non-REM sleep compared to REM sleep, but in the latter half of the night that is when REM sleep is prioritized. And so that's more or less an explanation for why oftentimes people will wake up from a dream in the morning is because the likelihood and the dry for REM sleep is so high during that time.

DANNY LENNON: With regards to those different stages and what we would ideally like to see on kind of two related questions which are really the different sides of the same coin I suppose and asking about what influences that sleep architecture or maybe put a better way if someone is trying to promote what we would think of as an optimal sleep architecture. Is there anything that goes beyond the typical things that we think about in terms of sleep hygiene to promote say getting enough sleep? Is there anything that it is particularly sensitive here that may disrupt that sleep architecture or change it or anything that we should be aware about?

ALLISON BRAGER: No, there are tens of things that can disrupt sleep architecture. The basics are a hot room, noise and external lights. But I think the best thing to protect to make sure that you get adequate sleep and that you are properly entering and maximizing your time in the deeper restorative stages of sleep is to make sure that you're going to bed at a reasonable hour. And what I mean by reasonable hour, I mean before 11:00 PM. And the reason I say that is because a lot of our drives for REM sleep are dependent on changes in core body temperature. And these changes in core body temperature are actually biologically programmed which means that it's nearly impossible to change the timing at which our core body temperature will drop. The best example I can give is people who frequently travel across time zones even though they may be doing this for years, decades on end, they still suffer from this timing issue every time they travel. And so this being said, when core body temperature is at its lowest the drive for REM sleep is at its height. And this drop in core body temperature typically happens between 2 and 4:00 AM. So if you're somebody, for example who is a night out and who is going to bed at 1:00 AM, 2:00 AM well, you might immediately hit the stages of REM sleep, but you're virtually not going to hit any of the stages of deeper non-REM sleep that you need to clear toxic waste from your brain, to repair your muscles, etcetera because of this tiny mismatch. So going to bed before 11 almost guarantee that you're going to maximize your time in deeper storage of sleep if you're doing everything else correctl y, such as minimizing all lights and all electronics from your room to sleeping and cool room to making sure even with bed partners a lot of times people suffer from sleep issues or at risk for sleep disorders because of their partner being a poor sleeper. So there is really no harm and not sleeping with your partner or sleeping with pets at nights as well.

DANNY LENNON: The point you made there I think most people will have experienced something similar if they're used to going to bed, say pre 11:00 PM and then suddenly they have a late night out sometime and they go to bed at 3:00 AM in the morning, they may still get eight, nine hours even of sleep. You still wake up and you don't feel that same refreshed feeling that you would have otherwise showing that that quantity is different depending on where it occurs, which probably ties into what you've just discussed I presume.

ALLISON BRAGER: Yeah, exactly.

DANNY LENNON: One thing that you did mention there is that some people may typically have later wake times and this kind of brings into the area of different chronotypes that people may have. So maybe first we should explain for people as a reminder what exactly we mean by a chronotype and then any thoughts you have around how does the inter individualization or variability I should say in different people's chronotypes play into these recommendations about what the optimal sleep and wake times should be.

ALLISON BRAGER: So chronotype is essentially a speed at which your internal biological clock kicks. So there are the series of molecular factors that determine how quickly like endocrine cycles and various physiological cycles in our body happen across the 24 hour day. Now the human biological clock is actually longer than 24 hours. I think it's hypothesized to be about 24.6 hours. And what this means is it's easier for us because our biological clock is longer to stay up later and go to bed later than it is to go to bed earlier. Now of course because this timing of our biological rhythms is controlled by genetic factors of course there's going to be individual variation in this response. However, most people tend to have a clock that ticks around 24.5 or 24.6 hours. There are cases of extreme larks and extreme owls. But to be honest with you, because this is genetically

controlled that's such a small percentage of the population. I mean we're talking like under 5%. But one of the things that we sort of believe in the research world is that because of having an extreme chronotype where say say your clock kicks at 24.3 hours because you're that person who goes to bed early and wakes up early, they tend to pre-select for certain career fields. So if you think about military personnel. If I ever had the opportunity to do a chronotype study across the U.S. military I would hypothesize that there would be way more early morning chronotypes in that population compared to any other population in America especially if I was looking at the cream of the crop. So like the special forces groups who do the most high risk commission and go after the most high value targets. I guarantee that a majority of those guys are early morning chronotypes and sort of have preselected into that career of high performance.

Now the opposite is true with artists and creative people. There's tons of stories from history of some of the most creative individuals in literature, in music and in arts who probably have very late chronotype. So maybe their clock is at like 24.7 or 24.8 hours. That also lends to being able to perform until one or two in the morning.

DANNY LENNON: There's probably one component we might have presumed of well people just adapt to a certain timeframe, but it's probably a pre-selection like you say of if you are going to be let's say a musician that's performing late at night regularly then if you're a late chronotype, then that may account for better performance and therefore allow you to rise more in that field and then vice versa for military folks.

ALLISON BRAGER: Right, Exactly.

DANNY LENNON: So one thing that I did want to ask on that is when it comes down to people trying to get a better handle on their chronotype if they're interested, obviously we can probably all have

an inclination to where we are and probably that can be relatively accurate and we can then go to the other extreme and look in research and look at measurements of melatonin and looking at dim light melatonin onset and all this type of stuff. But for people that are interested in evaluating their chronotype. Are there any typical resources you point them towards?

ALLISON BRAGER: There are questionnaires that you can use. One of the most common ones it takes honestly about two minutes to fill out and it's pretty widely available online is the Morning-Eveningness Questionnaire. And this first developed in the 80s, and it is a extremely robust and validated tool used often and not just basic sleep research but also clinical asleep research labs and there's sort of been a more advanced version of it developed out in Germany called the Munich Chronotype Questionnaire. And what's unique about the Munich Chronotype Questionnaire is that it does factor in the modern day world. So in the 80s, we didn't have a cell phone and electronic usage, but now we do. And so the Munich Chronotype Questionnaire also factors in technology to sort of help you gauge whether you're truly a morning person or an evening person. Now, ideally the most objective way to know if you're a morning person or an evening person is to do, to basically go on vacation and have your own free reign for two, three weeks on end. Essentially this is how these studies were done initially. So this is how we initially determine that the human circadian clock operates at about a 24.6 hours. This was done years and years ago at Mammoth Cave not too far from where I live now in Kentucky, where researchers basically had individuals lived down there for a month under constant conditions of lights and terms and conditions of routine. And it was through that, that they figured out that there's a mismatch between the 24 hour like third schedule of the day and the fact that the human circadian clock is the longer.

DANNY LENNON: With knowing that we have this genetic variation amongst people in their chronotype where they would naturally fall of course then there's situations where things are going to happen that's going to go against that. So in the example of you mentioned the military and obviously you've done some work with these folks as well. And for people who are would, may be in that situation, have a chronotype that would put them perhaps at a disadvantage. Is there a certain trainability to chronotype first of all, and then second, even if there is or isn't, if are there any strategies that you would recommend or have used with people to try and overcome some of those I suppose genetic obstacles that's put in place by their natural chronotype?

ALLISON BRAGER: Yeah. So that's a large part of my job is sort of tracking and monitoring sleep in real time and then implementing some sort of a counter measure as we call it to make sure that their individualized sleep schedule fits with whatever operation mission environment that this individual is going to be in. So honestly the biggest way to overcome this misalignment if you want to call it between your natural sleep wake cycle and endocrine cycle is driven by circadian rhythms and what you have to do for your job is proper stimulant use. Caffeine when used appropriately is a very powerful performance enhancing drug. The problem that most Americans have though is that we tend to drink the wrong source and too much within a short period of time. The wrong source meaning energy drinks. Energy drinks are never the answer. I can basically talk a whole podcast about why they kill brain cells and are terrible for your mental health. We've done studies and thousands of people now to show that they increased risk for anxiety, depression, PTSD. But I'm talking natural sources of caffeine. So green tea extract caffeine from coffee even some of these new nootropics such as Alpha-GPC. And recently I learned about

this new one called Citicoline anything that is plant-based compound that has been used for centuries, if you will, as a stimulant can help overcome these performance effects. And they've done these studies actually in elite individuals too. So there's this a very elegant study that was done a few years ago where they compared the performance of some of the best Olympic weight lifters and in general they found that the athletes who were lifting in the afternoon always performed better than the athletes really lifting in the morning regardless of their program chronotype. And there's a reason for that because when energy systems related to power activity or prioritize a majority of that is occurring in the afternoon and early evening. But what they found is for those who are at a performance disadvantage and that they were lifting in the morning, you could use something like caffeine from coffee in order to get performance to an afternoon level.

DANNY LENNON: Awesome. And then presumably that for those that did usually train in the evening particularly later in the evening, caffeine would be contraindicated for those athletes.

ALLISON BRAGER: Yeah, exactly. So caffeine would have no added benefit. That's actually a lot of what we find with our studies. I've done quite a few studies now with sleep deprivation and caffeine dosing and I'm also looking at genetic variation and sensitivity to caffeine coupled with sensitivity to sleep deprivation. And usually with these genetic study what you see if there's some genetic tradeoffs where if you're resilient to sleep deprivation meaning you're less effected by it, you tend to not have any added benefit from caffeine. So you tend to be a person who's more tolerant to caffeine whereas vice versa, if you're somebody who's sensitive to sleep deprivation caffeine like you are sensitive to caffeine. And you see that across the board and not just studies of sleep and caffeine use but sleep and other areas or any sort of like traits that you're comparing and in the real world.

DANNY LENNON: Just to pick up on the energy drink point that you made. With regard to the problems that you suggested that would have over other sources of caffeine. Is that down to other ingredients typically used outside of caffeine? Is it down to the dosages used or how people use these energy drinks? What is it about it that makes those uniquely more problematic?

ALLISON BRAGER: So I actually wrote [Indiscernible] [00:25:45] paper for the military about this a few years ago and a lot of it goes back to what they've found in animal models of caffeine energy drink use. So first that the amount of caffeine that is available in these products is more than the body can handle. So we've done studies in the lab to show that anything past 200 milligrams which is about two very strong cups of coffee has no added benefit in terms of performance. It doesn't matter how stressed or sleep deprived you are there's a ceiling effect past 200 milligrams. Most energy drinks have anywhere from 240 milligrams all the way up to 350 milligrams. So you are already you're giving this the system more than it needs and so what that's going to do is it's going to create drug tolerance just like with anything else. The second thing is yes, it has to do with the other additives put in these products. So caffeine activate excitatory neurochemical pathways at the brain. So glutamate and dopamine which are two of the primary excitatory chemicals. And then there's also other factors in there that actually can activate inhibitory pathways of the brain. So basically what you have is you have the brain receiving these mixed messages between excitatory and inhibitory pathways. And because of that, it rapidly stresses the brain out and it goes into this state of excitotoxicity which basically is premature neuronal cell death because the system has been overloaded.

DANNY LENNON: Super interesting. I wasn't familiar at some of that. And on the caffeine dose I've definitely

seen some sports nutrition literature suggest even dosages of up to I think it's say between 3 to 6 milligrams per kilogram of body weight is quite common to see which for I suppose an average athlete could put them up past 400 or 500 milligrams. Why do we see this discrepancy among some of these recommendations?

ALLISON BRAGER: So I think it's just it hasn't been carefully studied enough cause I think people just assume it's sort of this broad ignorance and assumption that any amount of tests like the more the better. But really just like anything else in physiology there's a very complex and calibrated approach.

DANNY LENNON: One thing that I did want to touch on, just as you mentioned, those people who can essentially have these strategies to overcome maybe different chronotypes one other aspect, and it's a term that I think I remember seeing from some of your work was around sleep resiliency. And I know that's kind of related to what we've already discussed, but for anything separate where we are in a place where we're trying to use interventions to acutely rescue performance that may be lost through sleep restriction and so on caffeine being one, is the idea of becoming able to bring up your baseline performance when you are in a sleep perspective state? Is that essentially possible or is it just a kind of subjective feeling that we're doing okay with our performance but we're actually still if we measured that physiologically still succumbing to the effects of sleep restriction.

ALLISON BRAGER: So there's actually a difference. So with total sleep deprivation, so somebody who essentially pools and all nighter they are able to have stable performance if they're using caffeine in a very calibrated manner. But this whole thing breaks down like chronic sleep restriction and we've done these studies too to show that basically after three days of only sleeping five to six hours instead of your usual seven to eight

caffeine stops working and the whole performance system shut down and the only way to get performance back to baseline levels is with adequate sleep.

DANNY LENNON: One thing that I also just thought of as you had mentioned the point about we have these different times and days that may lend themselves to better performance particularly in power sports. One thing that we see, we work with quite a lot of power lifters and if someone is training let's say later into the evening a lot of them may finish training sessions at 9:00 PM or sometimes even later. There's this potential issue of over arousal, pre-sleep or these are theoretically that could be the case. Is there anything that can be done in those situations to essentially speed up that time that is needed to get them into a good physiological state so to speak in order to best sleep? Or how would you approach that for people who do very arousing activities late into the evening?

ALLISON BRAGER: The consensus on this is whether it truly disrupts your sleep is still out. And that's the study that we would like to do. We're not quite sure if it's a physiological effect or psychological effect because it hasn't really been tested. It's more or less at this point, anecdotal evidence even though it seems to happen to a lot of people. But in order to get your body to calm down if you are that person who can't fall asleep after training late into the night you need some sort of nutraceutical pharmaceutical intervention. Now I'm not for existing sleep medications. I don't think those are ever the answer but I would recommend starting with something mild and more natural such as valerian root. Valerian root has been used for thousands of years. Cherry root extract is also good because this is a natural source of melatonin and even just to think about the lighting environment. So we talked about dim light melatonin onset. Well, the easiest way to accelerate a melatonin onset it's just being around dim light and doing things that are

essentially calming to your mind. So again not being on your phone, not watching TV sort of operating in very low natural light reading, doing breath work, something very low level.

DANNY LENNON: One thing that I think you had alluded to earlier Allison is not only that we want to have this low light or darkness environment close to sleep to help with that onset of sleep and help with melatonin production but for say a robust circadian rhythm it seems important that on the other end of the spectrum earlier in the day getting daylight exposure. What are typical recommendations that you may give to people in terms of how much time they might need to try and get some daylight? How soon after waking that should take place and any strategies that they can try and use if that becomes difficult based on typical schedules that people have?

ALLISON BRAGER: Honestly, it's sort of a day job and a night job and it begins very early. So as soon as you wake up in the morning one of the first things you should do is expose yourself to as much bright, natural sunlight as you possibly can. So basically going out, being in the sun, going in the sun with no sunglasses on to wake your body up sort of prime your endocrine system to get ready to perform throughout the day. And then there are studies now to shows that being in as much natural light during the day versus artificial light is way healthier for your physiological system for sure. Now at night yeah obviously it's different between the summer and the winter but you want to try to even minimize your amount of artificial light at night. There's nothing wrong with operating in dim light from the time you come home to eating, to winding down before bed. It goes back to like everything else, this nutrition and working out if you want to in the modern day world mimic what we evolved thousands of years before as much as possible in order to keep our physiological systems in check. The Neanderthals they were doing it right. The only thing we have that they didn't have access to

modern medicine and antibiotics and everything else. If they had all of that they would have probably outlived us.

DANNY LENNON: So in cases where people either because of their work schedule or where in the world they're living, maybe when they get up in the morning it's still dark outside they have to work in an indoor environment. Is something like a blue light box or blue light therapy for seasonal affective disorder typically is something like that, a viable option? And if so, do you have any specific recommendations for people who are looking at that type of stuff in terms of good versus poor products?

ALLISON BRAGER: Yeah. So there is, blue light boxes are pretty prevalent now. You can buy one for about $20, $30 on Amazon. There are clinical grade ones. There's this company Philips Respironics that sells one but honestly I don't think you have to go the expensive route these days because it is, blue light boxes are so commonplace.

DANNY LENNON: Whilst we are on the topic of different pieces of technology that may help related to our discussion earlier around sleep stages a lot of common commercially available sleep trackers now proport to be able to give you an estimation of those different stages of sleep. How accurate are they and are they of any use in trying to monitor say for example the amount of REM sleep you're getting and is that data actually instructive even if we were to have a?

ALLISON BRAGER: There are, [00:36:34] out on that. So this is something that I think the biggest challenge with the research and development [00:36:42] is trying to find something that is as good as an overnight sleep study. I do think there are companies who are closed because they have reported results now to show basically within 97% to 98% accuracy of an overnight study which is very good. Reliability those devices being the woop and then the aura ring. But yeah there is a lot of inter individual variation

in these devices. I think one of the biggest takeaway messages from a majority of them is that they are good for tracking your own individual sleep goals and sort of holding you accountable for how many hours of sleep because you can't hide from the number that's been reported on your screen. But in terms of accuracy between like time spent in non-REM sleep and especially REM sleep which is very difficult to do just using a wrist based device is still an evolving issue.

DANNY LENNON: Before we finish out if I were to ask you to someone walks up to you in the street and says, I just want a quick overview that you can write on the back of this napkin of what can I do in cases, in certain situations where I know I'm going to have poor sleep for let's say a certain day or two, or I've just had a poor night's sleep and I need to go and perform either cognitively or athletically what are some of the core first principles that you would make people aware of to try and look more into?

ALLISON BRAGER: So there's one and only principle, and that's sleep banking. That's something that we developed where I work a decade ago. If you can load up on sleep on the front end and you can protect yourself on the back end. I mean, it's really true. Sleep is truly like a bank account. The more you put in the more you can take out. And if you can prepare your body for that level of stress, then it's going to handle the actual stress that much better.

DANNY LENNON: Before I get to the very final question if people are interested in finding more of your work or more about you, where's the best places on the internet for them to go?

ALLISON BRAGER: So I am on Instagram at *docjockzzz* but I actually have a popular science book called Meathead: Unraveling the Athletic Brain that not only delves into the neuroscience of the elite athlete but there are two specific chapters devoted to how to optimize your sleep and circadian rhythms for the benefit of athletic performance and just having a high performing brain.

DANNY LENNON: Allison that brings us to the final question that we always end the podcast on. And this can be to do with anything other we mentioned today or completely divorced from that and it's simply if you could advise people to do one thing each day that would have a positive impact on any area of their life what would that one thing be?

ALLISON BRAGER: This sounds completely cheesy but I think there's so much evidence now for it is like daydreaming and practicing mindfulness. Like there's something about being in what we call in neuroscience, the default mode brain network that is not only good for our general creativity and daily waking performance, but having that downtime where we're lowering our cortisol levels and our stress system sets us up for success for having a good night of sleep.

DANNY LENNON: Awesome. A great way to finish and I want to say with that, Allison thank you so much for taking the time to come and talk to me and for all the information you've given. It's been an honor and a pleasure to chat.

ALLISON BRAGER: Yeah, no, absolutely. Thank you so much Danny.

DANNY LENNON: That was Dr. Allison Brager and if you want to get the show notes of this episode you can do so over at sigmanutrition.com/episode312 where you can find a transcript relevant links to this podcast that more background about Dr. Brager and then other related content to this topic. Whilst you're on the Sigma nutrition website have a look around and you can check out our Sigma synopsis email if you're not already subscribed. That's a weekly email I send out that you could look through in about 20 seconds that has relevant recommended content from around the internet. Also check out our backlog of podcasts and articles as well as our various coaching services. All of that is just available at sigmanutrition.com and then thank you for everyone who continues to listen

and support the show; the ratings and reviews on various different podcasts apps and particularly those of you who support the podcast on Patreon. All of that stuff is really, really appreciated. So thank you for doing so. I hope you've enjoyed this discussion and I'll talk to you in our next episode.

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