DANNY LENNON: Hello and welcome to Sigma Nutrition Radio. As always, I am your host Danny Lennon and you are listening to episode 176 today. And just in a short moment, I'm going to be talking to a researcher who has been absolutely cranking out research like there's no tomorrow, over the past couple of years. Eric Trexler from the University of North Carolina in Chapel Hill. And Eric is working in the lab there under the privilege of Dr. Abbie Smith-Ryan, who was on this podcast way back in I think episode 20 something, a few years ago. So really great group there and Eric is being in front an integral part of, some of the research they have been publishing over the past couple of years, which like I said is that quite phenomenal right. And Eric focus is mainly on research related to either body composition or diet and supplementation for athletic performance. And this is where we are going to dive in today and look at some of the various different supplements that have been evaluated in the lecture over the past number of years. Some more emerging ones, some of that of competition you have a benefit for performance and training, and various different types of activity and will dive into all that stuff in this episode. But before things do kick off, let me again mention something that maybe of interest to some of you that are based in

Europe. The European Powerlifting conference is being held in Arden this July. So, that's July 1st and 2nd this year. It's going to be a 2 day event, where you are going to be able to get access to world class information that's going to be presented by really I think 5 of the biggest names in Raw Drug Free Powerlifting. In fact, 5 of the biggest names is probably Powerlifting period in might to share of reacted training systems. Bryce Lewis of the Strength Athlete; Greg Nuckols of Stronger by Science; Eric Helms of 3D Muscle Journey and then 2 time world champion Brett Gibbs. All five goes in one place over 2 days this July and addition to all the knowledge and information you can get there, there's also going to be a special attendees party where at a prior function, you get to hang out and grab a beer with the speakers that are going to be there. As well as all, the fellow powerlifting enthusiast are going to be in attendance and just get to know some people, get to chat and then just kind of hang out in an informal setting. I think it's going to be pretty cool. So, if you want more details of that, then go to europeanpowerliftingconference.com, such as europeanpowerliftingconference.com and also in the league in the show of this episode as well, if you want to check that. So, on to today show and just as I mention the show notes, of course, you can access them at sigmanutrition.com/episode176, and to all link up to and the research we discussed today, a bit more information about Eric and anything else that's relevant to today's episode, that's sigmanutrition.com/episode176.

So, let's get Eric Trexler on the show and dive in to this week's episode.

Hey Eric, welcome to Sigma Nutrition Radio, how are you doing today?

ERIC TREXLER: I'm doing great. Thank you for having me.

DANNY LENNON: Before we get in any kind of specific stuff, can you just maybe give us an idea of the work you are currently doing at UNC, and ready your, suppose your academic career to date.

ERIC TREXLER: Yeah absolutely. So, I am a PhD student at UNC Chapel Hill. So, I did my undergrad and my master in exercise science

related topics. Body building and powerlifting really got me into science rather than the other way around. So, most of the work I do is really inspired by that in terms of my research. So, I came down to North Carolina, I guess it's been 4 years that I been here as a grad student. And most of the work that we have done so far, we typically – we do a lot of work with supplements, with performance and body composition. And that really has been the central theme. We've also done a little bit of work looking at some more specifically body building oriented topics. We actually just got a paper accepted in actual small pile of study in body builders and I have a case study in a body builder that's in review. So, if it has anything to do with body composition and performance, it's usually of high interest to me. I try to keep my research in that area and other related topic, I have to apologize in advance, I'm currently dieting pretty hard, so my brain – it will work if coerce to, but it does tend to – I find myself more and more frequently struggling to find a particular word on its – just low carb foggy phase, so hopefully we won't run into that.

DANNY LENNON: Yeah. We'll see what we can do. I'll try my best to keep you somewhat stimulated enough to be able to get some stuff out but just when you mention your background in body building and powerlifting kind of leading you to this root toward science. Can you maybe just give people some contexts of some of the stuff you've done, in those sports as well as your interest in, kind of outside of academia?

ERIC TREXLER: Yeah. So, as an athlete in High School, I did football and wrestling. And wrestling really made me fall in love with – you know in wrestling, there's so much weight manipulation I'm sure you're aware of. It really got me intrigue by how much our exercise and diet habits can influence our body composition. And it really brought me closer to physiology and so, once my wrestling career was over, I wanted to continue interacting with those topics on a practical level. So, I got in to some strength coaching every summer. In the meantime, I wanted to keep competing so I got into body building and powerlifting. I've done a couple of competitive seasons of body building and I guess three shows total. I've only done powerlifting need because I was really going after

a big goal that I wanted to get in a competition. I wanted to make it official. But I really been weight training consistently for probably about 14 years, which is a lot when you're 26. So, most of my life I've been training.

DANNY LENNON: Right, yeah for sure. I think that kind of gives us some context of how the interest arose and it's interesting you mentioned, wrestling being as one of the gateways because as you mentioned, it was obviously a lot of weight manipulation going on there and maybe we can touch back on that later on the show. But just to start off, I definitely wanted to center some of this talk around. The general theme of academic aids, specifically performance supplementation. And I know what I think of a lot of listeners are probably aware of that. A lot of the work that you have done has focused on I supposed, the big 2 so to speak, when it comes to performance supplementation, creatine and caffeine. But I wanted to, maybe look at some of the others outside of those 2 and some of the more ones that there's people with different questions about maybe are only hearing something, recently emerge, or stuff that as even being typically tallied for many years but maybe the research based on it, catching up to it now. So, if we look at some of those other supplements out there, I think a good place to start is Citrulline. And so, maybe before we get into your thoughts on it and what we conclude from research. Can you maybe explain to people why Citrulline is thought to be abuse? So what is the general propose mechanisms that people are talking as to why we even consider Citrulline might be something that's viable as a kind of supplement.

ERIC TREXLER: So when I first start into supplementation it was when nitric oxide booster where really kind of bursting under the sea, at least from my perspective. And so, there was all this products coming out that were jam pack with Arginine at the time. And people – they will always talk about this skin splitting pumps you get. And the idea was that, if you give someone Arginine it will increase their nitric oxide which will enhance blood flow. And you can look at blood flows effect on exercise from both perspective. You could say, well it enhances flow to the muscle which will probably deliver the importance things we need to see our activity. On the flip side, you could

say, after you're done and probably helps clear out some of those metabolites that result or contribute to fatigue and soreness. So, well soreness a little more debatable but definitely fatigue. But anyway, so that's where it started but the more research was done on it, the Arginine stuff they don't really pan out very well, especially in well trained people. And you go to some of the more pharmacological literature and it turns out a lot of the Arginine that we take orally, gets degraded in the gut before it really makes it out into systemic circulation. And so, people then kind of shifted the focus form Arginine and started looking more at Citrulline, which is involve in the same pathway of nitric oxide formation, just basically a different of the same pathway. And so, most of the time when people talk about Citrulline supplementation they are going to focus on the nitric oxide boosting component. The idea of being at all facilitate blood flow but nitric oxide is a lot more than just blood flow. And I don't want to get to far ahead but I would imagine we'll end up talking about nitrate as well. And a lot of that nitrate research has shown us numerous benefits of nitric oxide when it comes to exercise. So, we find that – it seems to affect exercise efficiency. So at sub max more intensity, you will spend less energy. It has some effects on calcium handling your force production in the muscle. And it appears to attenuate fatigue when it comes to really exhausted exercise. So that's the general part.

DANNY LENNON: Sure and I think – it's important I think we obviously laid out that nitric oxide production is kind of one focus of people look at and obviously one of the kind of impacts. We generally talk about getting a pump or just getting more blood flow there. But as you said, there's a number of things that can be related and have effects. Before we get to those, I think one thing that I think is important to maybe clear up is, I'm sure a lot of people listening may have looked around a different supplements, and would have seen Citrulline but in various different forms. So they may have seen it as Citrulline Malate, or you can see a lot of supplements, maybe L-Citrulline. So, when it comes down to Citrulline in this different forms, can you maybe explain the difference

between those, and why distinguishing between those might be important for someone to consider.

ERIC TREXLER: Like you said, the two most common ways are we going to see it are just L-Cirtraline alone or it will be the salt version of salt form where Citrulline and Malate are bound together. And it isn't an important thing to know when you look through the literature because both are use fairly frequently. I think the one main distinction that you can make, Citrulline Malate seems to get a lot more use in the resistant training literature which is a young but growing. There's not a ton of work with it but it starting to come out. And I think one of the things actually relates back to your first question, and that is, when we talk about Citrulline, we can't boil it down to just blood flow, especially when we talk about Citrulline Malate. Malate is not a physiologically inert substance, is actually – it does kind of – it's a part of the TCA cycle, citric acid cycle, whatever terminology you prefer. So, when we look at Citrulline there's the blood flow nitric oxide component, where Citrulline Malate there are potential effects Malate itself. And then Citrulline also, plays a role in the urea cycle with clearing out ammonia. So when we talk about Citrulline and Citrulline Malate, is important to distinguish, because the Malate might actually be playing an effect and like I said, Citrulline is not just blood flow enhancer is actually is quite more than that.

DANNY LENNON: Sure and so you mention the ability potentially with, to play a role in carrying out ammonia, which obviously has knock on benefits potentially. And another one that seems to get reported is also the role that's going to play in, as well as increase recovery of ATP and phosphocreatinine. So, when we are looking at to some of this propose different advantages that may have, when that's increase nitric oxide production, increase ATP regeneration, and its effects on ammonia clearance. In the context at least of sport performance, and I'm supposed this is a probably a 2 part question really, when we look at the actual literature, to what actual extent do we see, say increases in nitric oxide production or ATP regeneration and then be probably more pragmatically, what affect to those actual changes seem to

have on actual performance measures that this studies are using to evaluate their effectiveness?

ERIC TREXLER: Yeah so, it's a good question. What we do find is –you know in terms of magnitude, it's a very difficult to quantify because, when you think of what goes into that, it's well – what's your population? What does do they use? What form do they use? What type of exercise is use? So, comparing magnitude can be quite difficult but I can say this, when it comes to the formation of nitric oxide, Citrulline has been shown to increase that and not only that, but to a greater extent in Arginine. So, that issues been essentially resolved, as far as I'm concern with the literature. The ammonia clearance is a little bit hit or lesser in literature from what I can recall off hand. There is some evidence that it does occur but again it's – what can get a little frustrating with the Citrulline literature is that, often time's researchers have to pick and choose what will be measured. So, there's not a lot of papers that will sit down and lay out each of this things and say what we measured all of this potential mechanism that can contribute, and we are ready to layout, basically a road map of what really seems to be doing the job. You know right now, the Citrulline literature is kind of in its early stages where you give product, you evaluate outcome and then you say great. And if you look at a lot of the Citrulline and Citrulline Malate research, they are very much focus on we gave this dose, this was our performance outcome and then the discussion, they will say, by the way, someone should really figure out how this stuff is happening. And that actually a goal of mine. My dissertation work is very unlikely to involve Citrulline. And one of the things I'd like to do is, setup a fairly comprehensive where I can get an idea of – like you said, assessing the magnitudes of this different potential mechanisms. So that, once and for all, we can actually put them all out there on an even playing field and say, in the same people with the same dose doing this exercise, here's what really seems to matter, the hope is that we'll be able to parse out was really making meaningful contributions. So the benefits that we see in previous literature. But you know, if you look at one of the great papers on Citrulline Malate, I mean there's a like, 3 or 4 maybe that come to mine, that are

actually out there with resistance training. But one of the first I can think of Felipe Rissato which was in JSCR. They kind of lay out right in the discussion they say hey, there's 3 mechanism we suspect can play a role here. We're not even going to touch it. And that's no discredit to them or the previous authors that have done this work, that's kind of how it goes. If you look at something like – but you know, really, any emerging supplement, we kind of figure out, does it work? And then often times, okay now we need to parse out exactly why and how, and for who. So I think that's kind of where we're at with Citrulline Malate, is there's been a few papers Citrulline Malate answers Malate. There's been a few papers that have come out, that are starting to show some promising results. And now, I think it's time to get a little bit more elegant with the designs so we can figure out exactly what mechanism seem to make meaningful contributions. Because we hammered it out, what might play a role but it's time to actually to figure out what does? And so, it's an excellent question you bring up.

DANNY LENNON: I'm really looking at things from – okay – does this thing work first of all? And then, working back from there to try in, kind of decipher some of the potential mechanisms and really even beyond supplementation, we could probably say, that's the case in sports science in general. We've known things that work with athletes for a long period of time, and the field of sport science is trying to work out, why stuff matters, so we can make better recommendations and better evidence base guidelines I suppose. But to come back to our discussion here, so while we're still maybe trying to parse out some of this different mechanism that play and it's exciting to hear about what you got plan potentially to look into this. When it comes down to actual just performance measures regardless of how's that happening, what is the – at least the evidence that we have at the minute – what is that seem to indicate of potential impacts on performance and then what type of scenarios?

ERIC TREXLER: Yeah so. Some of the first there is to come out with Citrulline actually ugly enough then it look that grey. So there's a study by Hitner in 2016 where they actually find it too, poor performance a little bit but there's some really unique things

about that design that - I say unique, what I really mean is that they kind of bother me a little bit. It was a well done study, way ahead of its time but I wish they would have done a couple of things a little bit different. But you know, that's how it goes with research. But some of the more recent papers have shown when it comes to more time to exhaustion type test, with like cycling, the Citrulline does seem to benefit and basically helping to attenuate some of that fatigue. The research that gets me really excited is a – there's a couple of papers by Benjamin Wax, and there's the pink paper I already mention by Felipe Rissato. And they basically setup this research training protocols that look like there's straight up out of a muscle magazine. It's kind of – I think the Felipe Rissato one is like 16 sets of chest. I mean it's like your – it's your typical Monday chest day from Flex Magazine. 16 set to failure in a row, and yeah you can almost imagine that training template had like a picture of grey color on it or something. Basically, what that type of research is showing, a couple of a similar protocols by Benjamin Wax, what they are seeing is that, as you are taking resistance training to fatigue, for set after set. As that start to go on and on, we start to see the two groups really separate out. Where Citrulline is, specifically Citrulline Malate, is helping people accomplish more repetitions in the later set when they're fatigue. There's been 3 of this papers that I can think of, that have shown this very similar responses in terms of, the first set, you're probably not going to see much of a difference but as that fatigue accumulates throughout the work out, the two groups really do seem to separate.

DANNY LENNON: Interesting so, potentially then – I mean if we take the outside of a control environment, where we are not controlling for people volume. This is have to – I suppose possibility that someone is going to be able to get more benefit over a long period of time. To be able to increase training volume or get more training volume done. Or is it that – they will also have other things going on outside.

ERIC TREXLER: Yeah I mean, it's certainly possible to think that if you can use the supplement to accomplish more work in a given work out and to push your volume fire, there's a reason to believe that, that could contribute to improve adaptations over time

whether you're looking at strength or hypertrophy. Has that work been done? Not to my knowledge. Usually, the paradigm with this kind of research for now, is you bring in the participant, you gave him the supplement. 3 hours later they are out the door and that's it. So we don't really have, to my knowledge, a good study that say, yeah we gave to him for 12 weeks and after that Flex Magazine chest day, here's how much there pectorals grew. I'm not familiar with study like that. I do think that – like I mention earlier - I think this area of research is ready to start moving in that direction.

DANNY LENNON: Sure and I suppose or at least, from what I looked at, there is some research that looks at, maybe things that are indirect, as oppose to direct impact on sporting performance. You mentioned earlier, a couple of those, so for example, not in the fatigue but then potentially, some sort of indication or some people at least hinting that effects on muscles soreness as well. Do you think that there is anything in the literature right now that support its use for anything related to muscle soreness, muscle weakness, etc.?

ERIC TREXLER: Yeah I'm pretty sure that – of the three papers I mention with Citrulline Malate, I'm almost certain that at least one of them did actually measure soreness. I forget the exact – there's a few common ways to measure soreness in a research setting, I forget which one they went with off the top of my head. But I believe they did find a statistically significant improvement with regard to soreness. We've also seen a similar thing with pomegranate juice. And pomegranate juice, you have to kind of parse out, sure there's some antioxidant components but there's also a dietary nitrate component. So, it look like, there is evidence from both nitrate sources and Citrulline sources indicating that, there might be an effect there on soreness after a strenuous bout. And I find that to be very believable. So I do think that there's some merit to those kind of more indirect justifications as well.

DANNY LENNON: Sure and that makes you already good segment because I didn't want to bring up the pomegranate extract research you have been involved with. Because it's related to an area of research that I've found quite interesting to read over the

past time of years, looking at dietary nitrate I supposed, in a broader scheme, in particular some of the work done in the UK on beetroot concentrated shots in the context of athletes. So, with some of the work that you did on the pomegranate extract, and then I supposed, from just a wider reading of the related topics, where do you think we are right now, in terms of what we can actually fairly conclude about dietary nitrate supplements in athletic performance?

ERIC TREXLER: Yeah, it's actually a really exciting time for nitrate research and maybe because I'm young, I'm a little bit late to the party but there's been a tremendous amount of work over the last 5 or 10 years. Much of it, coming out of the UK like you mentioned. So, when we talk about nitrate sources, beetroot is the most common but you'll also see papers with things like sodium nitrate, and then we done worked with, pomegranate extract or pomegranate juice in other laboratories. But the idea is, that there's some dietary nitrate and there's often some kind of antioxidant as well. But what we know from the research so far, is that, this nitrate sources do increase nitric oxide production. They do I'm sure to increase blood flow and more importantly, they appear to enhance performance. Most of the performance, I hate when people just generically say, performance. That could mean anything. But most of the research has been done in more aerobic type modality, so like running, cycling things like that. And what they generally find is, it can increase your time to exhaustion, if you are just you know- if they hopped on the bike and say okay. Puddle if they can't puddle anymore. It also appears to pretty reliably reduce your oxygen consumption at a fix workload. So if you are doing submaximal work, you actually utilize less oxygen and ATP in the process. So, a lot of the work on nitrate has been focused on aerobic modalities and it's been quite positive from my perspective. What is interesting to me is – I'm sorry but they're starting to – what I was going to say, is they starting to expand out from that and so, there's been a handful of papers, more than a handful that have come out showing positive effects on sprint performance. And now, we are starting to finally see some resisting training work very slowly tripling out.

DANNY LENNON: And just maybe for some of the people who are not familiar with some of that work, is a lot of those potential benefits being derive based on just what we discussed earlier, or have you seen anything that seems to be, kind of exclusive to some of this nitrate rich dietary supplements, whether that be beetroot, pomegranate etc.

ERIC TREXLER: My gut would tell me that, that be nitrate is really tearing most of the load than nitrate through nitric oxide related mechanisms, and so, that's not just blood flow, it's also effects on the mitochondria, its effects on the muscle cell. So there's a lot going on with nitrate oxide. I think that is really carrying most of the load, in terms of performance, but not all of it. And there's actually a really cool paper that came out maybe a couple of years ago, but they compared beetroot to a nitrate match, those of sodium nitrate. And the beetroot, if I recall correctly did just a little bit better. And so, it looks like, there are some component to this plant base sources that might go just a little bit beyond the nitrate and I would suspect that what we're seeing is, that there is probably a little bit of synergistic effect with antioxidants. And so, you know when we look at things like pomegranate juice, beetroot juice, and actually Daren Will[?] just did some work with Citrulline combine with glutathione. And so completely a very different type of products but what we see is that, it looks like the antioxidants actually do help the nitrate or the nitric oxide pre course will work a little bit more effective.

DANNY LENNON: Very cool. And so, with this whole area of research and reading it I supposed it goes back to what we mentioned previously about Citrulline as well. Regardless of any of those areas, what are you most excited to see come out and emerge of the next few years, will that be something you directly involve with or the other groups maybe doing. Is there any particular research questions that you would like to answered that you think are more fairly close to looking up?

ERIC TREXLER: Absolutely, yeah. I don't want to get too specific because I actually have a grant that's already submitted to try to address some of this questions, so I don't want to like draw my research protocol and have somebody steal my grant work from me.

DANNY LENNON: Okay sure.

ERIC TREXLER: But yeah so, I did submit a grant about five weeks ago. So you know, this isn't hypothetical. This is really something that I'm excited to pursue and we're going to do it. We just kind of make sure that we get the funding's setup. But I really want to figure out and it seems made up based on your questions. We didn't discuss beforehand but I really want to figure out why Citrulline works. Because I started out being very skeptical about it. The more that comes out, the more I believe in it. And now, I want to figure out why. I want to figure out, kind of like you mentioned, we look at this different ingredients and their acute effects but I want to look at it more chronic type paradigm because no athlete in the world really cares about getting 2 more repetitions on one day of their life. You know what I mean? No one cares about that. What we are really trying to do, is figure out in the long term what can this do to for me? And so, I'm excited. I'm really eager to get into that particular question as well. And I think we have asked many of the right questions but I think we can do a little bit better when it comes to some of the more sophisticated lab techniques that are out there. So, and this isn't being hypocritical, some of our work with pomegranate, we looked at brachial artery blood flow with ultrasound. And that's an excellent way to look at blood flow. It's very cool and ultrasound lets us do some pretty amazing things. But I've been training like crazy on a technique that it's new to me, it's not you know, brand new. But I think near infrared spectroscopy when use appropriately can help us answer a lot of really cool questions in this area. And actually, I've been training under – I mean Lee Stoner[?], who is an absolute expert when it comes to measuring blood flow in none invasively. And his PhD student Adam Lazaro absolutely brilliant guy that he's built this kind of custom device that let us use the nearest in a really efficient effective way. So I'm extremely excited to start – you know basically, addressing this questions really head on and it's going to take time but men I'm excited to really start chewing on this questions.

DANNY LENNON: That's fascinating to know that stuff is kind of underway and the kind of vision you got for some it. And like you said, even

from this conversation I think people can probably tell that there's a lot of ready interesting and exciting questions to tease part. So, oh definitely will be looking out for, for what you got going on over the next few years with that. Eric, just to kind of, maybe bring some pragmatism to this 4 people listening, because obviously when we are talking about this in terms of concluding things from the literature, what is fair to conclude, what we already know. A lot of it can be – at least at this stage, we have to maybe tread carefully not to oversell certain things that there's not, I supposed a definitive research on. Before maybe an athlete out there, who's coming from a situation where they like, okay, I don't have any kind of financial restrictions here, I don't have an adverse reaction to supplementation. I've got all my basic stuff down with my trainings on plan, my nutrition and my sleep etc. I'm going to start playing around with some supplementation here based on just what you kind of think that the researchers hinting about some of the stuff we talked about. What do you think would be, maybe some of the things that might be worthwhile for certain athletes to start using it and start implementing just to see if it's going to play a role for them. What types of sports, for example to athletes, do you think should be looking at some of the stuff we talked about? And which ones you think are most worth there kind of time right now, to go and start playing around with?

ERIC TREXLER: So when it comes to the nitric oxide stuff, whether it's Citrulline Malate or a beetroot, you know the question is really, what task are you doing? What kind of – what is limiting you? And I know a lot of people like myself, that go into the gym when we just we lift weights and beat ourselves up for about an hour. You know, 4 or 5 times a week. I would expect that I would probably see some benefit with regard to fatigue resistant from either Citrulline Malate or beetroot. And you could throw pomegranate in there as well. When it comes to endurance athletes, I think one of the really exciting things about this nitrate sources specifically, and if were an endurance athlete I would probably go more the nitrate rout just because there's a lot more there, in terms of the research. But what we see is not only what help you with fatigue resistance on those really exhausting burst. But just a

general improvement and exercise efficiency. So even at submaximal loads making your training load a little bit more energetically efficient, I think might really help out in the short and in the long term. And then finally, like you said that, there's a couple of papers by I think its Jason Trumbo maybe. But couple of papers pomegranate juice where they showed improvements in soreness as well. So I think whether it's maximal or submaximal, if you got the money to spare, I wouldn't expect that either of this are really going to change your athletic career trajectory. They are not going to be absolute game changers but I do think they can meaningful contributions. The other thing I would say, is we do a lot of this work on supplementations but that doesn't necessarily mean that supplements are totally require. There's a lot of people that I think would benefit from getting more nitrate in their diet. Really regardless of what their scenario is. Because usually when you tell someone, let's get more nitrate in your diet, what happen is, their diet goes up in spinach, beets, celery, things that are just generally across the board, really darn good for you. So, like I know for me personally, they are delicious but even for performance this is well I start to have a lot more beets in my diet. And I think most people honestly, even if it has nothing to do with performance, would probably better serve like, getting some more of this nitrate rich foods in our diet.

DANNY LENNON: And so, I suppose a lot of those benefits, whether its obviously someone that want in – could be a strength athlete, that way many people as endurance athletes, and then probably, a lot of the sports have a like high glycolytic demand whether that's crossfire, MMA, soccer, football etc. could probably have a lot of those – I'm suppose that same requirement and same benefit from those things right?

ERIC TREXLER: Yeah I would like too. That's actually a really good point you bring up. So, some of the aspects of nitrate specifically, that particular pathway of nitric oxide formation. What we find is, you know with the Arginine, Citrulline route, that is an oxygen dependent aerobic pathway. When we looked at the nitrate pathway that's actually independent of oxygen. And not only that, it is stimulated by acidosis and hypoxia. So usually, when I see someone and I kind of blank on that

when you ask, it's darn contest prep diet. It's killing me. but when it comes to who I'm recommending things for, a lot of times if I'm looking at someone who works in that, heavily glycolytic range in terms of most of their energy expenditure. If you are looking for a tie-breaker, that might be cause to say, maybe we go to nitrate route rather than the – you know the Citrulline, Arginine classical pathway.

DANNY LENNON: Sure, now I know. Thanks for that input. One of the thing I do want to mention before we start finishing up, is I think it was year that you published a paper on, I think it was cordyseps mushroom supplementation. Can you talk a bit about that – how that study was setup? And kind of what you setup to measure with it – and really kind of why that was kind of, target of one thing that you guys want to look at.

ERIC TREXLER: Yeah. So the idea of the cordyseps paper, we were looking at cordyseps which is kind of just like, mushroom blend kind of botanical types supplement. And so there was an acute in a chronic phase to it and we are mostly looking at different types of aerobic type exercise. So this was not kind of – this wasn't within our realm of you know 0:38:24.8 fatigue resistance training type stuff. This is very much in the realm of more endurance type activity. So we looked at maximal oxygen consumption VO2 max, which is very standard measurement. We look at time to exhaustion on a pretty fatiguing protocol and then try to look at some oxygen kinetics mainly the threshold. So what we saw was, I think VO2 max improved in the cordyseps group but not in the placebo group. I believe we actually saw a change in the time to exhaustion with the mushroom as well. So overall, it look like there were some benefit when it came to tolerating more of that high intensity high end exercise. So in the context of the VO2 max test, you know being able to push through and go a little bit further and same thing with the time to exhaustion. But I do – if I recall correctly, I believe that those benefits were more so observe after chronic supplementation rather than acute. So the acute was just one week of supplementation and then a sub side of people actually went on for I think a total of three week of supplementation. So yeah, I would say the results were promise. There's certainly a lot more works to be done. It's one of those ingredients that

there's not a tremendous amount out there. But it did look like there was promising effect when it came to attenuating fatigue and allowing some of that higher end high intensity performance to continue. But again, it's the type of thing you would take more chronically. So you can think of it almost like a – you know with caffeine we expect our benefit right after we take it and then by the time we go to bed that night, it's gone. Right? That's an acute response. This will be more of the type of thing where it's like a creatinine that you are taking it daily and kind of overtime, you would expect to see a little bit more pronounce of the benefit.

DANNY LENNON: Yeah also – so it just something we can for the moment, at least file for promising and then potentially look forward for more stuff in the future to see where that goes.

ERIC TREXLER: Yeah I would say, the results certainly were promising, but you know there's one promising study out there for about every ingredient you can think of right. So especially in the world of supplement research, it's always about unfortunately practicing patients. And I do think that our results certainly showed some promising outcomes but you know, as it would – I would say what any ingredient until you got a few papers out there that are indicating that, you can't really close the book on it and say, well we did our work on it. That just kind of a nature of, I mean that's applied human research right? You kind of have to wait and see, in different samples, with different dosages. There's really got a comprehensive view of, what is this ingredient good for? At what dose for whom over how many weeks? And so, I would definitely file it in the category of being promising, you know if you are normal training or you're competition, it was within workload that are similar to those test outcomes we tested. I would certainly not see harm in giving it a shot. But it you know, like you mention, it's far from conclusive at this point.

DANNY LENNON: Where can people find out more about, either their cellphone online or some of the work their doing, or where they can track down some of your research paper or research gate profile, all that type of stuff, where is the best place look for more details about you?

ERIC TREXLER: Yeah so, my office is in the basement lab with no window, so I'm unfindable, physically, but electronically you can track me down. I'm on Facebook. I'm on Twitter. My name is just Eric Trexler, same thing with the research gate, Eric T. Trexler. Got some stuff on PubMed. I really need to do a better job of getting out there more like when it comes to kind of social media interaction. But you know, its killer Danny right now, I'm actually, I think I have 3 weeks left of course work in my doctoral studies. But you know for right now, I'm teaching, I'm doing research and I'm taking course work. So, there is just not a lot of time to get on Facebook and argue with people. But I assure you someday, someday soon I'll free up a little bit of time but yeah so, follow you know, get on touch with me on Facebook or Twitter, I do like interacting with people when prompted. I just don't go out and seek conversation as much as I like.

DANNY LENNON: Yeah and prior on this, our link up to all that stuff in the show at this episode as well as to the research paper you reference today. I think it's probably a good thing that you are staying away from social media as much you are Eric, and I think the reason why you are probably being so prolific over the past year is probably related for that as well. And I think a lot more us are probably better off. But yeah, I think mentioned on last week podcast that I just – how astounding it is that when you look at, how prolific you've been within the context of your academic career. And again, relatively short of comparison to the whole link of an academic career. But still so much published already, it's pretty amazing to see and so yeah, I totally can get why you might want to stay away from Facebook arguments because they lead on a road to nowhere to myself then.

ERIC TREXLER: They really – they do serve some benefit in some context but it really depends whose pushing them. You know sometimes it's just a complete waste of time. But I really appreciate that. I would like to, before we leave, I'd like to mention that we have been as a lab, we have been quite prolific the last 2 years. And it's been mostly result of being surrounded by some really good people. So my adviser is Abbie Smith-Ryan and she is absolutely tremendous I know you had her on the show. It just some of documents we have in the lab. We have

a really strong team of students and a really strong adviser that keep everything moving. And I will say I'm very excited once this course work finishes up. I'm hoping to become a lot more productive. So, I would expect there's going to be a lot a cool stuff coming out of our lab the next couple years.

DANNY LENNON: Awesome. I'm delighted to hear it and of course, Greg is going to be joining you guys later in the year when he start his, I think his masters this September, whatever it is. So you have plenty of cool people down there and I look forward to see more of that research. Eric, one last thing before we finish, it's the question I always in the show on, and this can be to do with anything completely outside of our topic of conversation today. And it simply, if you could advise people to do one thing each day, that would benefit their life in some aspect, what would that one thing be?

ERIC TREXLER: You know, I actually have a theory on that, it's completely unrelated but I have this thing, the first hour of your day. I really believe in setting very positive momentum for your day. And I also believe at least for me personally, I get my most clear thoughts the second I rolled out of bed. So for me, I will always reserve – almost always, reserve that first hour the day for my most in depth thought that I really need to do, so if there's a particular manuscript that I'm writing where I'm stuck, I'll say that's for tomorrow, hour 1. I will roll out of bed, get a cup of coffee and the first hour of my day, I get so much done. So much high quality thought before the all other stuff of your day can start clouding your head. And I would think a lot of people will stay on the benefit from reserving that first hour. It might not have to be for work. Maybe it just to get your head clear and get your mind right. But really emphasized from the – you know the first 60 minutes after you roll out of bed, do something good with that time. I recently started implementing and it's been absolutely amazing. It's the best writing I have ever done. Just that happen at 4 in the morning.

DANNY LENNON: Wow. That's awesome to hear and I think it probably just stay in the idea of from – just being proactive because I mean most of the stimulus that hits us each day, that we have to go and react to, where that someone sending us an email or a

new message, or something that we have to do for work. It's all kind of reacting to stuff as it happens, where as if, it's a situation like you got line where you have that time block that off the first hour you are getting something done, you at least accomplished something before, any other external stimuli comes in so. That's sound pretty awesome.

ERIC TREXLER: Yeah just set the tone for your day perfectly. It is funny the days that I don't do it, what you find is it's amazing how much time you can waste getting your day started. And you'll be like – It'll be 9am and you haven't done anything and you're like, that's just 3 hours of productivity. 4 hours that just disappeared from my day. So yeah, I would say that's – I'm surprise this came to me in this mental state. But that would be my parting comment.

DANNY LENNON: No, that's awesome. And yeah, a great way to finish off this episode and with that, I want to say, thank you so much Eric for taking the time out to do this because I know how super busy you are and if we take up, and give up an hour of your day to come and talk to me is very much appreciated, and not only for that, just for the work that you are putting out into scientific community and the work you can continue to do, just to let you know that it is, appreciated and I really look forward to seeing more stuff that you publish into the future.

ERIC TREXLER: Well, I had a great time. Thanks for having me on.

DANNY LENNON: So that was Eric Trexler of UNC Chapel Hill, and if you want more details about Eric, about the research he is doing, links to those research papers, show notes, a bit about background all that type of stuff, then just go over to the show notes page, which is at sigmanutrition.com/episode176 and there you will also get information about how to get transcripts of the podcast episode if you so wish as well. And remember, for you powerlifting fans that are based on Europe, if you want to hear more details or interested in going to the European Powerlifting Conference that's happening this July in Arden, then just go to europeanpowerliftingconference.com to check out details of this summer's event. I think it's going to be pretty epic and for any of you that do end up getting into kit

and are planning on coming, please do let me know in advance that you listen to the podcast and you are going to be there and it will be good a chance for us to hang out and chat in person. So let me know if you are planning on doing that. And apart from that, for everyone else, thank you so much for listening to the podcast today. I really hope you got something from it and learn something new or found a new area to maybe look more deeply into at something new came up on your radar. And that's all we can really hope for with the show, trying to bring out more information and make you aware of it, for you to go and do what you wish with it. So hopefully we achieve that today, and I appreciate you listening and downloading. And also for the continued support that all of you provide here and sharing this on social media, for people mentioning it on their Instagram stories, people tagging me on Facebook and the post they made, for people that are tweeting all about. All that type of stuff makes it a massive difference and especially for those who are going on leaving or you to keep the show up here at the point it is, in the iTunes chart and keeping it higher on the radar of other people maybe who haven't heard the show yet. The reviews are the best way we can do that and that's how we can help stay in towards the hop of iTunes. But you guys going and leaving your review so, if you haven't done so, all you have – maybe you are long time listener and you just haven't got time, then I realize it's a bit of a hassle and it does take time or might just slip your mind, that's totally cool. But if you do remember, and you do have a quick 60 seconds to just go onto iTunes, leave a quick review for the show that does mean a tremendous deal. And then finally, if you do want to support the show and be a patreon, we do have a page there, such as patreon.com/sigmanutrition that's P-A-T-R-E-O-N and yeah we have details over there of how you can officially support the show and I'm thinking of doing something more formal with that to really trying get back to those you who have been supporting the show on patreon over the past few months. I'm planning on doing something with that so yeah, I'll give details when they are ready. So that is it for this week show. Thank you like I said again, so much for listening in and I'll leave it there and I'll talk to you in the next episode.