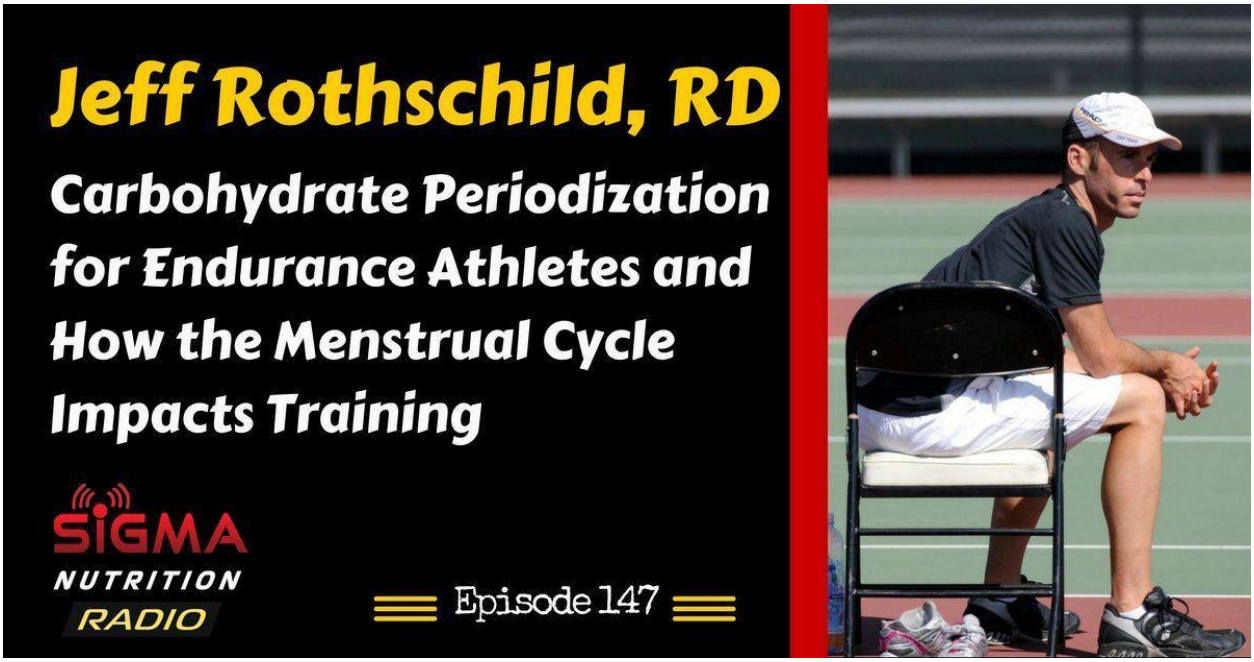

Danny Lennon: Hello and welcome. My name is Danny Lennon and you are listening to Episode 147 of Sigma Nutrition Radio, the podcast that gives you access to weekly discussions with the world's leaders in evidence-based nutrition, health and performance.

Before we jump into today's episode, just to let you guys know that the new Sigma Nutrition and Performance T-shirts are available to buy on the website right now. So if you just head to SigmaNutrition.com, you can just select apparel from the menu and then you'll get all the information on the new T-shirt, and you can go and get them now. If you want to represent Sigma Nutrition, they are there and they are awesome.

Today I'm delighted to have sports nutritionist Jeff Rothschild on the show. Jeff is both a registered dietitian as well as having a master's degree in nutritional science, and he works with a variety of different clients including on the tennis side he has like elite ATP Tour players/NCAA players. He also works with a ton of endurance athletes and competes himself. He's worked with boxers and swimmers. So, a ton of different athletes with different demands and we're going to going to get into some of that hopefully today.

In addition to that, Jeff is also a writer for Examine.com, their monthly research digest where he puts up articles, and teaches sports nutrition at CSU Los Angeles as well. And what I really like about Jeff is that he

follows an evidence-based approach to nutrition but not only just by looking at the concepts we're seeing in academia and keeping up-to-date with that. He's actually finding ways to take those and put them into practical application with these athletes and finding ways of them to use what we're seeing in research in actual real-world terms and seeing benefit from that. He's also authored a number of different papers that have turned up in the literature, in peer-reviewed research papers related to nutrition. So, really, really cool guy and we're going to get into some really cool topics.

In today's episode, we're going to talk about a number of concepts that have shown promise in research and then discuss how Jeff actually implements those things in the real world with endurance athletes. For example, one extremely exciting area in sports nutrition is the application of carbohydrate periodization or purposely having training sessions or recovery periods whilst having low levels of glycogen. So you may have heard of terms like "train low, compete high" or "sleep low" and "recover low" strategies that have been discussed a couple of times on the show before essentially having either, like you say, a training session that's done with low levels of glycogen due to previous depletion and then not restoring glycogen levels through taking in carbohydrates or, after a glycogen depletion session where someone used up their glycogen, not restoring that straight away and instead sleeping overnight or just going through a period of recovery time without restocking glycogen and doing that in a low-glycogen state, or actually doing another training session in a low-glycogen state with the idea that this gives different adaptations to the muscle with different enzymes and different things with mitochondria, these adaptations that are going to be different than if that same session had been done or that same recovery had been done with full stores of glycogen. And so really, it's about programming certain training sessions and recovery times when the athlete is going to be training with those low levels of glycogen just in order to get that adaptation rather than get full glycogen stores, which we know are going to be better for actual performance in that session. So, super-interesting stuff and Jeff has been doing some really cool stuff of implementing this with different athletes in different contexts, so taking this and seeing it work in the real world. So that's what I'm really interested to hear.

Anyway, before I say anymore, let's get straight down into it. You can find the show notes to this episode at SigmaNutrition.com/episode147 where

you can also get a transcript of the episode as well. So without further ado, let's get Jeff on the show.

Hey Jeff, welcome to the show.

Jeff Rothschild: Hey Danny, thank you so much for having me.

Danny Lennon: It's my pleasure to have you on. I think there's a ton of interesting stuff that I can't wait to chat about today, some things that we'd been talking about obviously over email and not only related to the clients that you work with but also in topics like intermittent fasting, which I know you've done some work with our good mutual friend Dan Pardi, who's only had very good things to say about what you've produced in that area and talked through with him, and so I can't wait to get to some of that stuff. But maybe just to kick us off here, for listeners that are unfamiliar with you and the work you do, can you maybe bring us through a bit around your background and then to the work you're now currently doing and the people you work with and how that relates to what you've done in the past?

Jeff Rothschild: Cool. Yeah, absolutely. Well, I'm a registered dietitian. I did my master's degree in nutritional science. On the sports side, my whole life I've played tennis and I used to play competitively and still do a little bit. Also, I'm a cyclist and an endurance athlete. So I have spent five years as a college tennis coach while I was doing my master's degree. So I have a pretty strong background in tennis and in endurance sports, and that's kind of translated to now that I have a private practice in Los Angeles I tend to prefer working with that population. So yeah, that's kind of the brief background.

Danny Lennon: Perfect. I think that really sets us up well for some of this discussion, and it's with endurance athletes in particular that I'd like to start this conversation because when it comes to nutritional programming for endurance athletes, I think maybe there's no other area of sport right now when it comes to nutrition where there's this much debate around either this kind of argument for or against going super-high-carbohydrate versus on the complete other end very low-carb, high-fat or even a ketogenic diet to try and improve sports performance, and there's kind of these two polar opposites and it seems to be endurance sports where there's most debate probably typically because of the energy systems used, but when we're then looking into the research, obviously we then have this point where it's not as polarizing, where we're looking at potentially using carbohydrates

in different places and kind of periodizing that a bit more to get some benefits. And I think previously on the podcast, for example, people have mentioned the work that maybe James Morton and some of his colleagues have done around carbohydrate periodization or Trent Stellingwerff, for example, and looking at glycogen availability research and seeing how that translates to carbohydrate recommendations. So I'll be really interested to know, number one, what you have taken from all the available research we have on, say, the glycogen availability or carbohydrate intakes for endurance athletes, and then, how has that translated into what you actually do and what you implement with your endurance athletes? What do you think is the best kind of way for them to think about this whole area of carbohydrates?

Jeff Rothschild: Yeah, I try to stay very current with that research and I'm a big fan of it and the work of the guys you mentioned. Really, really fascinating. I think for me it's probably the most fascinating area of sports nutrition research. I get fairly, fairly often people asking, endurance athletes asking about ketogenic diets and we're talking about triathletes doing sprint or Olympic distance or road races for cyclists, and I'm generally not a fan in that case. My kind of stock answer to them is things that are beyond ironman distance even. That's my take. I'm sure people would argue with that, but…

So as far as putting it into practice, yeah, that's really…it's really interesting and it's kind of…it's a part of what I do that I really enjoy, is to say, "Okay, here's all this great research and it's a lot of fascinating stuff, but how do we fit it into people's workout schedule?" So I'll give you…I guess the best thing I could do is give you a few examples of some athletes and how I've taken these concepts of manipulating the carb availability.

One guy is an age grouper but a really high-level triathlete and kind of competing in the half-ironman distance and he'd come to me, and he's already a very well-established athlete and had a lot of success, but a lot of people, this is a good example of the carb availability of something that most people, the athletes at least, aren't as hip to it or don't understand the finer points. So this guy was doing two workouts a day, kind of early morning and then late morning or midday, and he would do kind of…he would wake up and do a fasted high-intensity interval workout and then kind of eat breakfast and then have a longer-duration endurance workout. So thinking about energy systems and carb availability, it was actually an easy thing and which he was totally happy to do, is just swapping those

two workouts so he could wake up, do a fasted workout, eat, and then have his higher-intensity workout in around 11 or 12. It kind of seems like an obvious thing and it's actually worked really well for him.

Another example, there's a girl, a woman, also another high-level age-group triathlete, she would do a morning run and then an evening…a late afternoon spin class. So, again, thinking of like the "sleep low" carb study as I think of it as, just getting her to do protein after her spin class and then sleep with that low carb availability, wake up, do a fast and endurance run, and then eat, kind of resume normal after that, also been really helpful.

And it's such a small tweak in that for both of these athletes in the course of a day they're basically eating the same amount, but just being able to manipulate the time of when they're taking it in, it can lead to I think surprisingly big effects. And we're talking about athletes that they're already close to their peak, meaning like someone who's untrained, of course. They can do anything and they're going to get a lot of benefits. But when you have athletes that have been competing for 15 or 20 years, it's hard. They're at their limit. They're approaching their limit of…they have to put in a lot of effort to get a little bit of adaptation. So in these two cases, it's been really effective.

Just to give maybe a couple more examples, another guy who's a road cyclist, he just trains once a day and he has a fairly high-stress job but, again, a high-level age-grouper athlete. He trains in the morning and, you know, it's just not that applicable. I couldn't figure out a good way to fit this carb availability in. A little bit if he's doing just an easy ride or a hard ride, but as far as like day training it just didn't really work out. So you have to say…I taught him the basic concepts of fueling for the work required and if you're doing a zone 2 kind of easy or a longer endurance workout, keep lower carb and at intervals we can do with some carbs in the system.

And then, I guess I'll give one other example of a pro cyclist who's training three times a day in his hard training blocks. Of course, there's backoff weeks built in, but these hard training blocks are beyond brutal. So that's another case where perhaps there could be some benefit but he's already on the verge of being broken from this training, this planned overreaching. So with him, I would look at his training peaks as like where the coach puts in the workouts, and I wasn't able to do it very often but we were able to say, "Okay, here's a good day to try this after this workout, just protein only, and then sleep without carbs and wake up and

do this workout fasted, and then resume," things like that. We were able to kind of really sporadically put in some of these where I'm not sure if there's a benefit that he got from it, but it was just otherwise he would just be broken by the training, which is, again, at the level for this guy in particular, his total volume was just off-the-charts high, but that's what he needed to drive adaptation.

So, I guess, is that helpful to kind of…? So I really feel like here we have these tools and here you have the athlete's schedule and their experience and their background and their training and all that stuff, and you're trying to fit them in together.

Danny Lennon: Yeah, for sure. I think that's super-useful to hear some real-world examples, and I think it kind of highlights nicely how it's not always going to work or there are going to be certain occasions where it's not possible just purely due to the type of training or the training schedule or even the timing of those sessions that the athlete has. And I think probably a nice way for people to kind of think about obviously when we look at why this could potentially be beneficial, we are starting to see some of this research emerge that when some training is done with lower levels of glycogen, so this kind of "train low" concept, we can get some sort of positive adaptations for like mitochondrial biogenesis and other different changes in enzymes, etc., etc., or similarly with the kind of "sleep low" like you mentioned or "recover low" during recovery periods, having lower glycogen, so not restoring glycogen straight away and we're getting these nice changes or at least seeing that's hinting towards in the research that there are changes, say, to the mitochondria and at cellular level.

When it comes to not only taking that, so like you said, and putting it into practice with athletes, but talking through the rationale with athletes—obviously we're not going to delve into all these potential cellular or molecular changes—how would you talk through with them why these protocols are being done or how for them to even think about having different days or different timing around their carbohydrates and how that relates to potential improvement in performance?

Jeff Rothschild: Yeah, that's a good question, and it's super-important because in my kind of situations I'm not talking to someone every day on any regular basis, so I have to really explain the concepts so that they can be the judge and make sense of, "Okay, is this a good time to do this?" On occasion, like I said with the one guy who I'm looking at his training plans, that's not the norm. So yeah, it was a big light bulb for me when I first started thinking

about this and hopefully I can set the same light bulb off in these athletes, is that we have fueling for peak performance and fueling for peak adaptation, and those maybe traditionally used to be thought of as the same thing but as we've been learning they're not necessarily. So, explaining that the signals that your body are getting are a driver of adaptation and not just, let's say, the power output itself.

So maybe to make a better example, if we give someone carbs and caffeine and they're going to do let's say an interval workout or any kind of workout, they're most likely going to do better. They're going to put more power out, run faster, whatever it is. But if someone has to do something similar on an empty gas tank, they might not feel as good or put as much power output, but that's going to drive…that's going to send a stronger signal to your body that, "Hey, we need to step it up here and make more mitochondria and all these things." So, explaining it kind of…or I usually will grab a water bottle and, "This is our gas tank, our carb gas tank, and if you've depleted it then that's kind of sending a different signal than if it's fully stocked up." So just trying to give some kind of tangible examples to let them understand basically the concept of a full gas tank and an empty gas tank.

And then at the same time I think it's really important to know, and almost as a disclaimer, that this then becomes a bigger stress on your body, which maybe I should have mentioned earlier. For that pro cyclist who's training three times a day—as I mentioned, he's already under a huge training stress—adding an under-fueled or under-recovered chunk of time, that's adding more stress. So I'm super-super-conscious, I'm aware that there's already a huge training load with a lot of these athletes that's actually mind-boggling, so I'm really careful not to put them…cross that edge too much into over-training. So I want them to understand that it is a bigger stress on their body. If they are doing this kind of protein-only and no-carb recovery after an evening spin class and they start sleeping poorly, they start waking up in the middle of the night, having to go to the bathroom more often, that's a red flag that, "Okay, let's not do that or not do it as often." Yeah, I really want them to understand why we're doing it, what it's going to benefit.

And again, using that concept of fueling for the work required and when someone understands, and this is…also kind of as an aside, I'll do a metabolic testing so we can see what someone's burning and…but even without the test during exercise, you explain to someone that you're burning generally more fat in the aerobic zones and more carbohydrate

reliance in the upper zones. And so if you're doing high-intensity intervals it's relying on carbs. If you're doing a long recovery ride or like just a long endurance ride, then it's more fat-driven so you don't need a ton of carbs. And once people start to understand these concepts, I think it can be really beneficial.

Danny Lennon: Yeah, I really like the wording you use of talking about fueling for peak performance versus fueling for peak adaptation because I think that's the perfect way to think about this in that for, like you said straight out, for any one given session depending on the type of fueling strategy or what someone chooses to eat beforehand or before their previous session, they're either going to determine whether that's going to be the most likely to be optimal for a high-end training performance or, like we said, we could have a situation where maybe they're not trying to get the best performance in that session. They're trying to get some adaptation of the muscle, which is where, say, a training with low levels of glycogen comes in. So do you think then that…or how do you try and structure that with people that there are going to be certain training sessions where when the focus is on getting, say, an adaptation through low-glycogen training, obviously that means that it's likely that if they were to try and get their best performance in that session it's not going to happen? Is that something that you make people aware of of saying, "Actually, for this session, it doesn't really matter that the performance isn't as good as it could be because we're trying something else," or is it a matter of only using those lower-glycogen-availability sessions when performance doesn't matter, so like you said, like a recovery run or something like that?

Jeff Rothschild: Yeah, yeah, that's a good question. I think it's…I'll usually look at their existing training plan and endurance—let's say someone's training for an ironman and then in oftentimes like a Saturday will be just progressively longer, so they might have 60 miles one week and 70 miles the next week and so on. And so that's just about getting the miles in. Or, another example with a track cyclist, the morning workout will be like a roller, so just at-home roller spin where most of it is kind of easy and then it increases towards the end with some intensity with some high-cadence things. So that's an example where there's no…I mean, he can be looking at wattage and things but it's really about spinning the legs, getting the time in at the different cadences and things like that, and so that's the perfect time to…and it's a nonissue how fast they're riding, you know?

So yeah, I guess I would say…and people should know the purpose of a given workout. If someone's at that level of training—a zone 2 is like a

long slow duration…or long-duration slow-endurance ride—no one's hopefully trying to ride too fast. If they are, they're kind of selling themselves short. If they're doing like a group ride, again, if we're thinking cyclists, those aren't long. Those aren't zone 2 rides. Those become basically races for most people. So, we got to know that's going to be where you really want to ride fast, and so you got to fuel.

So I think having a clear plan…and that doesn't even necessarily mean having a 24-week training program written out. It's maybe at the beginning of each week or even each day knowing, "Okay, this is meant to be a zone 2 ride. This is meant to be my hill repeat intervals, long intervals. This is meant to be my 30-second repeat intervals." Whatever it is, that should be…it should then be pretty obvious. And then the times that are, like I said, like a group ride or a group run, then kind of that just becomes a more mixed type of event.

Danny Lennon: Sure, yeah. No, that makes a ton of sense. I think it's been really useful to hear how some of this exciting research has been translated into those very practical pieces of advice and structures and protocols with certain athletes. And keeping on kind of that same kind of theme when we're talking about taking something from research and using it in a practical with a higher-end athlete, and again, if we think about endurance athletes, one area we had kind of earmarked was supplementation because, especially in the field of endurance sport, there's been some exciting research again emerging over the past number of years. Now, obviously, some compounds that initially showed some promise failed to actually prove beneficial, but a number of others seem to be really useful both in research trials but then anecdotally in practice, and we're starting to see some that even over the last few years have emerged as things that are starting to become more regularly used with endurance athletes that maybe weren't there a number of years back. So when those come to endurance sports specifically, Jeff, what supplements do you find not only are most useful on either, say, a high-end training day or even race day but beyond that, how do you go about dosing and timing of supplements on race day of those ones that you find are most beneficial for performance directly?

Jeff Rothschild: Yeah, that's another great topic. There's kind of the I would say more or less agreed-upon supplements that are beneficial for endurance athletes. So let's say carbohydrate, obviously; caffeine; creatine to a degree, depending on the type of riding; BeetElite or the beet powder, beet juice; beta-alanine can be helpful; sodium bicarbonate; even sodium phosphate is kind of a new one, which I'd like.

So yeah, it's very tempting and easy to say, “Okay, here's a list of things that an athlete should do,” but when you're sitting across from someone and you say, “Okay, here's what I want you to do. We're going to…” and let's say they're on board. They want to just be faster with everything legal and safe, so they might say, “Yup, BeetElites/beets sound good. Bicarbonate, sure, we'll make that work. Caffeine, yup. I got to eat a carb meal beforehand. Okay, beta-alanine. And maybe some sodium loading.” All of a sudden, with a 7:30 in the morning race start, they're looking at you like, “How in the world do I get this all in?”

So of course some things take some time to build up in a system. So beta-alanine, that's something that I'll have someone do…it seems to be at least about four weeks till you see something with regular dosing, and then it seems to be…you can take it longer and it seems to keep building up in your system. So that's one that I think the research is really mixed, but I think it's underrated in the endurance world and maybe I shouldn’t [chuckles]…I should keep that to myself. But I'll tell you, the reason is we think about it between one- to four-minute efforts for beta-alanine is just kind of the thing, and most research studies that use cycling or testing endurance athletes, they're oftentimes using either a time trial, a longer time trial or short intervals or whatever it is. And I think some do a good job at simulating race conditions. For example, there's a study in sodium phosphate that really does a good job of—I can send it to you because I'm blanking on the author but—they do a good job of simulating a race condition. When you look at the power output of a road race, depending on the rider and the type of course, obviously, they’re really a series of one- to four-minute efforts. Now, time trials would be different, again, and depending on the type of rider and things, but I find it really helpful, even though you might be doing a 100- or 80-mile road race, it's a series of short efforts, not to mention the final push where you really obviously want to be strong if it's someone that can win.

So I'm a pretty big fan of that BeetElite…or, again, I keep kind of saying BeetElite and over here that's kind of more popular, I think Beet It is the popular one in the U, but anyway, the beet products, it seems like it's mixed between you get some benefit from an acute dose and some bigger benefit if you've been loading it. I know some people that I'll have some people do it maybe three or four days leading into a race, so like the three or four nights before and then that morning, couple of hours before. It takes about two hours or so and a little longer to peak in your blood, I believe. I have one guy who stays on it for all on-weeks, so a really hard-

training, high-volume athlete, stays on it and then stops doing it on off-weeks because he's seen other people do that and I don't really see a problem with that especially coming off it at least for some time.

Caffeine of course is an obvious one, and then bicarbonate. Again, that's another one that people I think tend to write off to a degree because they say like that the amount that gives you a benefit will also make you go to the bathroom, and that's certainly the case where if you do too much you will go to the bathroom. And it tastes absolutely terrible. But that being said, and there's also a recent study that shows how much variability there is in the optimal dose for someone, so that has a lot to do with having someone play with it, figure out how much they need, how far they need to space it. So I have one guy that can do it like 30, 60, 90 minutes before a race, Another guy needs to spread it out by about an hour, and they both find benefit from it and they're both super-super-fast cyclists.

So, I am a fan of that, but then again, now you start thinking back, "Okay, we've got the morning…" let's say a race is even 8 a.m., which is on the late side. You've got to your beet powder in let's say around 6:30. You've got to get some caffeine in there somewhere. You've got to get at least two doses of the bicarbonate. That can get tricky. And then, again, if it's hot I am a fan of some of the sodium-loading products. So it's really figuring out, I'll find out, "Okay, what time does your race start?" and then we kind of can work backwards. Some people need to it a few hours before and some people can eat a little bit sooner. I definitely try to figure out exactly what time their race starts and then work backwards from there, maybe have a bicarb dose the night before and move that way. But that's one of the most challenging things, is figuring out, "Okay, we have all these great tools."

And then, pre-cooling. There are some interesting new studies on that. So whether it's drinking an ice slurry or a facial spray or things like that, that I think can be very effective depending on the length of the race and things like that. So that's one more, you know, okay, so now you're telling the person, "You've got to do beets…" let's say for that 8 a.m. race, "You've got to do the beet powder at maybe 6:30, the bicarbonate at, I don't know, 7:15 and 6:15 or something, caffeine somewhere in there. If you want to drink an ice slurry, that's got to be maybe 20 minutes before." So it becomes kind of a math problem to try and get them without…and then of course making them feel like they've just consumed so much stuff that they're too full. So yeah, it's a constant like…something that requires constant manipulation, I think.

Danny Lennon: Yeah, I think the big thing to take there is, well, obviously when we have a list of these supplements and nutritional protocols that can have a benefit, not only does it become a timing issue and trying to preplan that and schedule it out but, as you alluded to with the individual variety with how different people react and the benefit they find or the dose they have to take or the dose that becomes too much, there's obviously a lot of trial and error for any given individual athlete that's going to be superior to just looking at, say, the dosage used in one type of study. So do you, with all your athletes, get them to almost have like a test day where it's not in competition where they're going to trial these different amounts of supplements or trying to time it the way they would on a race day so that they can essentially know what they should be doing as opposed to coming to a race day, doing all this stuff that they've heard about, and then suddenly it kind of backfires on them?

Jeff Rothschild: Yeah, yeah. No, absolutely, that's a great point. We try to, always with the bicarb for one, I definitely emphasize to just start with one dose. It starts very slowly, and then the next time you try it start with two doses. So that's…people can get comfortable that way. Yeah, and then as far as the synergy for this, you try—and a lot of these athletes are racing with road cyclists, especially kind of at the semi-local and age-grouper level, they're racing a lot, so you have the luxury of the, let's say, less important races and you can try different things and really tweak it through the season, and then by the time like state championships or national championships or I guess even the Olympics come around, it's a little more dialed in, yeah.

And then the other thing, too, is kind of figuring out—and again, this is where the education of the athlete comes in and the type of event. So if you're doing a time trial, I would usually say it's probably not that beneficial if it's a 30- or 40- or 50-minute time trial to do the bicarb if it's just a steady effort, but in that case then maybe some of the…not necessarily the mouth-rinsing but I'll have them put like a shot block, like a chew basically in their cheek, which does—it should—I know most of the studies are using mouth-rinsing, but it would seem there's no reason that having a chew, a carbohydrate chew in your mouth for 10 or 15 seconds before you swallow it or in your cheek, shouldn't do the same thing. So it's kind of figuring out, again, "This is our tool set. Here's the race scenario and what things could be beneficial."

Danny Lennon: Yeah, I think that's super-interesting and I think it's just, again, coming back for not only the planning and things of that nature but more so of being educated enough to make smart decisions around that and not be

kind of clutching at straws to a certain degree come the time and event rolls around, which unfortunately sometimes happens with certain athletes.

One thing I did want to kind of transition into, Jeff, because I know you've written a really, really good piece on this before, was some of the issues that pop up specific to female athletes and things that not only they should be aware of but also probably their coaches should be aware of. Because on this podcast before, we've discussed things of how the, say, menstrual cycle can affect general population dieters or people who are gym trainees in relation to things like body weight fluctuations, for example, then obviously on the athletic side, how those body weight fluctuations are something that weight-class-based sport athletes, females, need to be aware of. But in relation to impact on athletic performance directly, it's not something that's really been touched on, and in know you've done some really good work at looking at this and then how that should apply in the real world to female athletes. So what should female athletes and their coaches be conscious of, and then how do you translate that information into the practical application and protocols based on the menstrual cycle?

Jeff Rothschild: Yeah, this is an area I find really interesting and, definitely first off, a hat tip to Stacy Sims who's been really one of the loudest proponents of getting more research in women and seeing how things, you know, the physiology is really different. And yeah, I tend to refer to it as girl stuff just to add a little bit of levity, and it's such a taboo topic also. Yeah, I wrote something in kind of reference to tennis players but it's certainly applicable to all athletes and especially endurance athletes as well.

I think it's certainly under-researched. That's totally clear. The research in some degree, in some ways, is a little contrasting or sometimes shows no effects, but there are so many variables that have been well-documented in some of the review studies, the review articles, as to why some studies don’t show something and some do. But some basic things, body temperature changes. So actually, I guess I'll just give like a three-minute primer because a lot of guys have no idea about this stuff and I didn't, and I spent five years as assistant college tennis coach coaching girls and that's kind of I think what started piquing my interest, seeing that there…at the time I didn't know a lot of this but there was my observations of seeing variations and different responses.

So basically, a typical cycle is 28 days and now not everyone is on a typical cycle, but just for the purposes of discussion. It's roughly divided into a front half and a back half. So that's called the follicular phase and

the luteal phase, and then in the middle is ovulation and the first day of her period counts as day one of the cycle.

So imagine these two chunks, 14 days on each side. Body temperature increases at ovulation and stays elevated for about seven to 14 days. So if we don't think about anything else, body temperature, basal body temperature, is elevated, and it's not a huge amount but it's still something. And so in cold weather it's not a big deal, but if you're talking about exercise in the heat, there's then less margin for heat accumulation before your starts pushing back effectively and saying, "We need to slow down or we're going to overheat." So right off the bat you can say okay, well, cooling can become more important, so any of the pre-cooling or intra-workout cooling mechanics for endurance athletes or a team sport can be really helpful" because the basal body temperature is up.

Then, there is this…the estrogen comes up towards the end of the front half and then comes back down, and then the estrogen and progesterone both come up in the middle of the back half, so the mid-luteal phase, both of these hormones up. Now, these have differing effects and it's a really fascinating area and I'm going to keep it really brief in that one of the most noteworthy effects is how plasma volume and fluid balance changes. So Stacy Sims did a really interesting study where women received a set amount of electrolyte-enhanced beverage in the front half, so in the follicular phase, and then in the mid-luteal phase, which is like if you think about days 19 through 24. And drinking the same amount, the changes in the plasma volume were completely different. So what I mean is in the front half of the month, the plasma volume, which is an indicator of how much fluid was absorbed, increased about 6% by the end of the time period, whereas that same amount of fluid having been consumed in the mid-luteal phase only raised the plasma volume by about 3%. So what that means is the fluid you do drink during let's say the mid-luteal phase is not going to be absorbed as well as the same amount of fluid being consumed during the early part of the month, so again, where the women's body temperature is up during this time and you're not hydrating as well. Basically, your body is hotter. It's not hydrating as well. That becomes very relevant when exercising in the heat. So that means, on a real practical level, drinking more to get an increase and adding more electrolytes or basically sodium can be really helpful. I guess we could go on but I think those are almost the biggest key take-home.

And then, oh, actually, sorry, one other important point on this I think is ideal exercise intensity should change. The front half of the month is a

better time generally for high-intensity training, and then the back half of the month or that mid-luteal phase, you're going to see a faster time to fatigue at high intensities. So there are kind of a couple of options. You can decrease exercise intensity and focus more on endurance or that's maybe a good time to take your recovery week or that's a good time to do more technical things, maybe watch film if that's your sport or whatever it is. Or, if you do need to exercise, of course there are competitions that can occur, you're going to again remember that you need more fluids and salt and also more carbohydrate. So you'll need more because the way your body accesses glycogen is different in these times of the month, so simply taking more sports drink with carbohydrate can then kind of even out some of these changes between the phases.

Danny Lennon: Yeah, some of that stuff is really fascinating and it's great for people to have some sort of reference of where to make certain practical changes and then how to do that over the course of a month and have a valid reason why that they can kind of point to but being able to show how that translates to practical things people may be doing, and like you say it could be something that's quite simple to implement, but they need to have that knowledge in the first place.

Do you have any kind of anecdotal reports of, say, females that you've worked with who, since coming to work with you and you've been able to implement some of this stuff, have been able to see those benefits, very real benefits from making those changes or just being more conscious of it in, say, how they set up their training and how they periodize their training based on that, or how they change their fluid intake or sodium, for example, across the month?

Jeff Rothschild: Yeah.

Danny Lennon: What are sort of results you've been able to get with people?

Jeff Rothschild: Yeah, I definitely have anecdotal reports. I don't have any…I wish I had something more like sound, like some result change or something in a race performance, but definitely most women are very interested and receptive to this. A lot of times people don't even know what day of the cycle they're on, so the first step is just to get them to get an app and there are plenty of free ones, and you can actually just start being aware of, "Okay, where am I?" Then, yeah, shifting your training around. I've had a handful of women saying, reporting it's good, it's beneficial, it makes sense, they feel better, all these things. Again, I don't have any like wow statistic or

anything, but people definitely anecdotally are open, they're trying and they've had good results.

I'll tell you an interesting story. There is a tennis player, a college tennis player that I knew I wasn't working with at the time but she had a tennis tournament and it was two days. She's a good player and she had to play a couple of matches each of two days and she had muscle cramps, and then I wasn't there but then the third day she was fine. I told her to consume a bunch of like miso soup—I talked to her that night—and so high sodium and fluids, and she was fine the next day. But then, a week or two later, I explained this to her and to her teammates these kind of concepts and I was actually able to guess, I said, "Did your cycle start on this day?" And she was like, "Yeah," which meant that when she was having those muscle cramps and struggling with the heat and things, she was in that mid-luteal phase. So definitely…and that's happened on a number of occasions where you kind of can look back and go, "Okay, that's why I was struggling," or "that's why I felt so hot" or couldn't deal with the heat or whatever it.

Danny Lennon: Yeah, I think that awareness is probably just as important as any, say, potential improvement in training performance or whatever, just being, like you say, having that awareness and then being able to look back retrospectively and say, "Well, I was suffering from cramping but at least I know now here's a possible or a probable reason why," as opposed to then feeling they did something else wrong or that the training load is wrong or something that they have now a solid reason. And the same thing the way we talked about earlier, people correlating, say, change in body weight, at least now there's a clear explanation once they're aware of it and once they've been tracking and once they just have an awareness of what their body is doing.

Jeff Rothschild: Yeah, absolutely. Yeah, I think it starts with the awareness. And another actually interesting study I just remembered, you know, we talked about the plasma volume. So it's so important. Decreased plasma volume, so if someone's sweating a lot and trying to deal with the heat and they already have a decreased plasma volume, that's going to lead to reduced sweat rate, which makes it tougher to control your temperature; lower blood pressure; and an increased heart rate during exercise. So it could be a difference of six to 10 beats per minute at a given workload during the mid-luteal phase compared with the follicular phase. So that's huge, and especially with endurance athletes that are so kind of obsessive, for lack of a better word, on things like heart rate. If they're running a, I don't know, 7:30 or eight-minute-mile pace at X heart rate, and then they're running it

again at…next time they're running at 10 beats higher, that's alarming. So then it's kind of understanding, well, it's tougher to hydrate, so you need to go hydrate, be a little more proactive with it during that time, maybe again extra sodium and trying to get that plasma volume back up.

Danny Lennon: Yeah, I think that's a really good point especially just how common it is, like you say, for people to track the recovery of their heart rate to base on improvements or even people might be using heart rate variability or other types of tools, where if they aren't aware of some of this stuff then kind of it's skewing what they're seeing and maybe they're perceiving something than what's actually going on. So I think that alone and outside of the potential for improved performance is worthwhile for people to consider.

Jeff, some of this stuff's been really, really good and I did want to maybe get into some fasting, but I think maybe the best thing because we're just coming up on time is maybe to…we could get you back for a round two, we can dive all into that stuff, because I think there's been so much so far for people to digest. But before I get to the final question, maybe first can you let people know where they can find more of your work online, where they can find you on social media if they want to contact you or find more of your work? Where is the best place to go?

Jeff Rothschild: Thank you and absolutely I'd be thrilled to be back and talk more with you. I think the easiest thing would be to go to my website and that's Eat.Sleep.Fit, so www.eatsleep.fit, yes.

Danny Lennon: Perfect. Excellent. So I'll put that link in the show notes for people and make sure you go and check that out, and I'm going to link to some of the pieces that I mentioned earlier that Jeff wrote that I found particularly interesting. Jeff, that brings us to the final question we always end the show on and it's simply, if you could advise people to do one thing each day that would benefit some aspect of their life, what would that one thing be?

Jeff Rothschild: Yeah, I think it would have to be moving, not only moving every day but multiple times. So I think doing an hour of exercise in the morning and sitting the whole rest of the day is not so good, so if you can figure out a way to walk to the store, walk to lunch multiple times especially if you're otherwise sitting, I think it's just so vital to get, yeah, a number of different even if slow-intensity activities. There's a statistic on, I think it might be one of the step trackers, and it's number of hours per day where you hit more than 250 steps, and I think that's one of the most important and

underrated markers because that shows you're moving multiple times through the day instead of getting let's say 10,000 steps in one go.

Danny Lennon: Yeah, awesome. Yeah, no, I completely agree. I think that's when people think of an active lifestyle so often they kind of maybe fall into the trap of thinking, “Well, I'm going to the gym every day, so I'm counted as one of those active people,” but like you say, if it's one hour in the gym and the rest of the day you're completely sedentary, that's not really an active lifestyle or what we're kind of maybe supposed to be doing. So, some really solid advice. And like I said, Jeff, this has been some really, really good information that I think people will find really useful especially because of the practical nature of taking some of this research and being able to apply it, which is a kind of disconnect that sometimes people can have. So I'm delighted you're able to share some of this with people, and like we said, hopefully we can hook up a round two and have you back on.

Jeff Rothschild: My pleasure. Thanks so much.

Danny Lennon: There we have it. Check out the show notes at SigmaNutrition.com/episode147 to get links to stuff that Jeff discussed today, some of those articles that he mentioned, some of the research that was related to what we discussed today as well as getting a transcript of the episode.

And before you go, just a couple of things to bring to your attention. First, if you are interested in weight-cutting strategies and performance nutrition for fighters, then I have something super-exciting that's about to launch. The Sigma Weight-Cutting System for MMA and Boxing is nearly ready to bring to you guys. It's been worked on for a long period of time trying to pull in together all the stuff we can take from the evidence base and then merging that with what I do with professional boxers and MMA fighters I work with and trying to bring that down into an exact system that you can roll out for yourself if you're a fighter or that you may find useful if you do work with those types of people. If you want to get more details on what exactly that is and how the system is going to run, or be notified of when it's going to be released, then if you just go to SigmaNutrition.com and in the top menu you will see a Weight-Cutting tab. If you just click on Weight-Cutting, it'll bring you through to details and you can sign up to stay notified about that.

Secondly, whilst you're there on the site, you may as well grab one of the awesome new Sigma tees that I mentioned at the start of the show. They're

super-high-quality T-shirts that we're shipping worldwide and if you just head over to the site you'll find them there. And if you want to represent Sigma Nutrition and have an awesome T-shirt, then you can get them there.

So that is it for this episode. I will be back in the next one later on this week and until then, have an amazing week. Thank you so much for listening.

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