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Collagen for Soft Tissue Injury and Repair

Analysis by Dr. Joseph Mercola | Fact Checked | July 02, 2023

STORY AT-A-GLANCE

- Collagen-based tissue includes tendons, ligaments, cartilage and fascia — basically connective tissue — all of which tend to get weaker and less elastic with age
- Connective tissue requires very specific raw materials, namely animal-based collagen such as gelatin and bone broth. Your body cannot produce the essential amino acids that make up collagen, so you must obtain them through your diet
- Collagen is high in glycine, proline and hydroxyproline, and relatively low in branched-chain amino acids, which are the primary ones that stimulate mTOR, muscle anabolism and muscle building. For that reason, it does not count toward your daily protein intake
- To optimize endurance, use a heart rate monitor and calculate your max heart rate based on the formula of 180 minus your age. This formula gives you your maximum aerobic function
- 180 minus your age is the heart rate at which enough oxygen is being put through your body to fuel fat burning, and to not put you into glycogen or sugar burning

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Mark Sisson, a former elite endurance athlete that qualified for the 1980 U.S. Olympic marathon trials, founder of the popular website Mark's Daily Apple and a leader in the paleo movement, was one of the first to help me understand the importance of burning fat for fuel.

Here — after we cover some of the basic benefits of high-intensity interval training and strength training, we segue to the topic at hand, namely the use of collagen for soft tissue injuries and repair, along with a few other useful fitness tips.

> *"How I came to [learn about collagen] was how I arrived at a lot of my epiphanies — I had a life crisis. I play ultimate Frisbee once a week, every week for the last 15 years now. But about five or six years ago, I started to develop severe Achilles' heel tendinosis.*
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> *Ultimate Frisbee is a very fast-paced game … There's lots of running … [and it] requires a lot of agility, a lot of side-to-side quick movement, as well as raw speed …*
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> *I found over a couple of years, in my late 50s, that I was starting to get these real severe Achilles' problems. I couldn't sprint. My Achilles' were really tender. They were getting thick. I went to see an orthopedic surgeon [who] said, 'You have severe Achilles' tendinosis.' I go, 'What does that mean?' 'Well, you're screwed, basically. You can't play sports again' …*
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> *An orthopedist in Southern California said, 'Well, here's what we're going to do. We're going to take the back of your heel, slit it open and scrape the Achilles' down to the raw meat. We're going to pack it up in a cast for three months, then you'll do nine months of rehab and you'll be 85% of where you were.' I'm like, 'No. That's not going to happen, Doc … '*
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> *I went back to my house and said, 'You know, there's something I was doing wrong here.' I started to do the analysis and I thought, 'Here I am stressing my Achilles', which is attached to the calves, so I'm really stressing the calves, the plantar fascia and everything around it, on a regular basis. I'm not giving my body the raw materials it needs to recover from that stress. It is that simple.'"*

Collagen for Soft Tissue Repair

Collagen-based tissue includes tendons, ligaments, cartilage and fascia — basically connective tissue — all of which tend to get weaker and less elastic with age. Injuries are also worsened by the fact that there's very little blood supply in connective tissue, which slows down recovery.

While a muscle injury is fairly easy to fix and recover from, connective tissue require very specific raw materials, namely animal-based collagen such as gelatin and bone broth. This collagen material is amino acids that get incorporated into your body to become this matrix of connective tissue. Sisson adds:

> *"Even if you say, 'Well, I can get all of these raw materials from the amino acids in the meat that I'm eating, or in the protein drinks that I'm drinking,' the reality is you can get some of those, but not in the quantities that you probably need, particularly as you get older and particularly if you start stressing these tendons, ligaments, cartilage and other connective tissue and fascia.*
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> *Having done the analysis, I started supplementing 40 grams of collagen a day. Within four months, my Achilles' were better. I could have two scars on the back of my leg and be all pissed off about the surgery that I had that didn't quite come out the way I was promised.*
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> *But I'm here telling you that I just got off the track, where I ran 32 seconds for a 200 at age 65. And that's the first time I've been to the track in probably six months …*
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> *If you talk about gelatin, collagen peptide or collagen bone broth, we're talking about the same peptide. We're talking about glycine, proline, hydroxyprolines — some of these really specific amino acids — dipeptide, tripeptide that actually cross into the bloodstream as a unit and get incorporated into the body."*

Your Body Selectively Takes Collagen Into Stressed Areas

The Achilles' tendon can be envisioned as a coiled spongy spring, full of fluid. Each time you stress it, the tendon tightens, pushing the fluid out. As the tendon relaxes, fluid

flows back in. Sisson cites research showing that when subjects were given a collagen drink 15 minutes before performing a jump rope exercise, collagen peptides in the bloodstream surrounding the tissue were incorporated at over two times the normal speed.

> *"That was a fascinating study to me, which indicated that it's really happening the way I envisioned it — that the body will selectively take in these collagen peptides into the area being stressed, particularly if you don't have any other source of raw material in your diet,"* Sisson says.
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> *"Even in the paleo world … you're eating choice cuts of meat, but you're not gnawing on the bones or the skin or the tendons or other nether parts of the animal … Most of us don't make bone broth anymore. We've had decades of not having any access to collagen.*
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> *I see it in pro-sports, where athletes are tearing anterior cruciate ligaments (ACLs), medial collateral ligaments (MCLs), tendons and all kinds of stuff. I'm going to have to say that a lot of this is because their diet is so horrible to begin with, and then they don't take in supplemental collagen that I think would be probably wise on their part."*

The Difference Between Collagen and Other Protein

As mentioned, the collagen Sisson recommends for soft tissue repair is high in glycine, proline and hydroxyproline, and relatively low in branched-chain amino acids, which are the primary ones that stimulate the mammalian target of rapamycin (mTOR), muscle anabolism and muscle building.

For that reason, while 40 grams sounds like a lot, it does not count toward your daily protein intake, which I typically recommend keeping around 0.5 grams per pound of lean body mass. Above that, you start running the risk of overstimulating mTOR, which speeds aging and raises your risk for chronic disease, including cancer.

Since mTOR is not stimulated by collagen peptides, you don't have to worry about exceeding your protein intake when taking a collagen supplement.

> *"Twenty grams a day is for my maintenance level of collagen,"* Sisson says. *"But you hit the nail on the head. Collagen is such a unique protein blend of amino acids and it's so specific to collagenous material in the body that it does not sustain life.*
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> *When you buy a collagen product and it says 10 grams per serving or 20 grams per serving of protein, because it is protein and it has to say protein on it, when you look at the supplement facts panel on the back, it's zero of the daily value. In other words, it cannot sustain life."*

Back in the '80s, a 500-calorie-a-day liquid protein diet was all the rage. Medifast and OPTIFAST were two of the big brand names. This liquid protein was in fact collagen. People believed they were getting 500 calories in the form of protein on a daily basis, but because it was collagen, it was not enough to live on. People actually died on this diet.

I actually had a number of patients on this program in the mid-'80s before I understood nutrition. Now I realize that a 500-calorie partial fast can actually be very healthy but should only be done a few times a week, and must be cycled in with a high-protein, high-carb diet in a really specific sequence. Also, there are better proteins than collagen for a partial fast. I go into great details on this in my book, "Keto Fast."

"They had congestive heart failure, arrhythmias and things like that, because it was not the right kind of protein to build muscle," Sisson says. On the other hand, as long as you didn't pursue it for too long or too exclusively, you could significantly improve health as it maximized autophagy.

> *"That's the good news-bad news … A lot of people wound up having great skin, hair and nails and lost some weight. That was the upshot of that. Anyway, it was such an interesting concept that even the World Health Organization, the U.S.*

Department of Agriculture and the Food and Drug Administration say, 'You can't live on collagen protein.'

They're basically acknowledging that if you eat collagen protein, you're doing it for skin, hair, nails, tendons, ligaments, connective tissue, bones and fascia — a lot of structural components in our body that are well-served by doing a daily dose of some form of collagen.

That's also why bone broth has become all the rage in the health food circles in the last five years … Here's my shameless plug. I had such a great experience with supplementary collagen, I created a collagen product line within my Primal Kitchen food line, as I am so clear on people needing to supplement with collagen on a regular basis."

Types of Collagen

While 28 different types of collagen have been scientifically identified, most supplements will contain one or more of just three of these, which are known simply as:[1,2,3]

- Type 1 — collagen found in skin/hide, tendon, scales and bones of cows, pigs, chicken and fish
- Type 2 — formed in cartilage and typically derived from poultry
- Type 3 — fibrous protein found in bone, tendon, cartilage and connective tissues of cows, pigs, chicken and fish

Types 1, 2 and 3 comprise 90% of the collagen in your body.[4] When talking about collagen supplements, you also need to know the difference between unhydrolyzed (undenatured) or hydrolyzed (denatured) collagen. In their natural, hydrolyzed state, collagen molecules are poorly absorbed due to their large size.

Hydrolyzation refers to a processing technique that breaks the molecules down into smaller fragments, thereby enhancing intestinal absorption. For this reason, most

collagen products are hydrolyzed. As for the difference between collagen and gelatin: Collagen is the raw material and gelatin is what you get when you cook the collagen.[5]

> *"Bovine-sourced collagen are the basic element, probably covering 80% of the bases,"* Sisson says. *"There are different sources of different blends of collagen peptides. Some are higher in proline. Some are higher in glycine. Some are higher in hydroxyproline.*
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> *But they all have kind of the same sorts of dietary peptides, just at relatively different levels and different amounts … And then we have hyaluronic acid, which is another factor in some of these products.*
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> *I'm basically saying that [you can] cover 80% of your needs with a 100% grass fed, naturally derived bovine source of Type 1 and a little bit of Type 2 collagen … As for the rest, you're just splitting hairs. That's how I feel about the Type 1 and Type 2 stuff."*

Nonorganic Collagen, Bone Broth Products Likely CAFO-Derived

Keep in mind that many collagen supplements are made from animal parts derived from animals raised in concentrated animal feeding operations (CAFOs), and may contain unwanted contaminants, including heavy metals,[6] chemicals such as butylparaben, and drugs,[7] including antibiotics.

If you do not consume **factory-farmed/CAFO meats**, you likely should not be consuming CAFO collagen and bone broth products. While CAFO-derived collagen, bone meal or bone broth may not be acutely toxic, purchasing food products from factory farms is a problematic practice.

I recommend eating mostly organic and **grass fed foods** — and that includes collagen from these sources — as each and every source will add to your overall toxic load. To avoid exposure to CAFO-related contaminants, make sure the product is "100% USDA Organic" and/or certified grass fed by the AGA.

On Dosage

When it comes to dosage, there are no hard and fast rules. Sisson, being willing to experiment on himself, decided for a larger-than-normal dose and took 20 grams of collagen twice a day to start. After a few months, he cut down to a maintenance dose of 20 grams a day.

> *"I thought, I'm just going to bathe my Achilles' in this raw material,"* he says. *"I think there's a rate limiter on how much your body can absorb … It's not like you're going to hurt yourself … [But] you still have to deaminate the excess.*
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> *Some of it might be converted into glucose, because there's that whole gluconeogenic aspect of excess protein. I used to think I had high protein requirements but all of a sudden I was like, 'Geez, my daily protein requirements might be 50 to 75 grams a day.'*
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> *I feel great doing that. Anything I eat beyond that isn't building more muscle, isn't causing me to burn more fat. It's just extra calories that the body has to figure out what to do with.*
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> *Again, do I convert it to glucose and burn it? Do I convert it to glucose and store it as fat? Do I deaminate it and pee it out? Do I keep it temporarily in the nebulous amino acid pool or sink that's in the body?*
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> *In the last couple of years as I look more into this whole protein thing, I don't even think in terms of meal-to-meal or even day-to-day. I sort of look at protein intake in three and four day clumps.*
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> *If I get 180 grams of protein over three days, I don't care how it came in or when it came in. That's enough to keep me going, because the body is so efficient at recycling, particularly when you're fat-adapted and keto-adapted. It's so efficient at not feeling like it needs to dispose of that protein."*

The Importance of Pulsing Your Protein and Carb Intake

Personally, I've found I need to pulse my protein intake. I'll restrict it below 15 to 40 grams a day a few days a week, then increase it to 70 to 100 grams on my strength training days or post partial fast. While you don't want to chronically stimulate mTOR, you also don't want to chronically suppress it. So, pulsing or cycling seems to be the best way to go about it.

The same can be said for carbohydrates. While nutritional ketosis requires you to severely restrict net carbs while increasing dietary fats, chronic carb restriction is inadvisable. This is why I recommend cycling in and out of ketosis once you've established that your body can efficiently burn fat. As explained by Sisson:

> *"I don't like the word 'ketogenesis' because it connotes an excess of ketones in the bloodstream. To think that you're going to have an excess of ketones in the bloodstream all the time for the rest of your life is ridiculous. I talk about keto in the same breath that I talk about fat-adapted and keto-adapted. The term I use is 'metabolic flexibility.'*
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> *We want to be able to burn fat when it's available on our plate. We want to burn fat when there's no food available. We want to burn glycogen when it's in our muscles and there's none available.*
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> *We want to burn carbohydrate on our plates, and when it's available [as] glucose in the bloodstream. We want to burn ketones when there's no glucose. And, as the very last resort, we want to burn amino acids because it is a substrate in the absence of other substrates.*
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> *But metabolic flexibility means we've developed this internal combustion system that is equally adapted, extracting calories from all these substrates, not just dependent on carbohydrate every three or four hours, which was the old paradigm. But certainly, also not just adhering to a keto diet for the rest of your life with no more than 20 or 30 grams of carbs a day."*

Living Your Best Life

While I believe wearable fitness trackers, like an Oura ring that has no EMF when it is airplane mode, can be valuable, Sisson is a self-proclaimed "anti-wearable tech person." Instead, he believes it's important to become more intuitive in your approach to lifestyle choices.

> *"How do you look, feel and perform? When you wake up in the morning and you do a workout, are you ready for that workout? Do you feel like doing that workout? Are you excited about the workout? Do you have enough energy when you wake up in the morning?*
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> *If you're not hungry, do you still have to eat? No. If you're not hungry, why are you going to eat in the first place? A lot of this is just developing an intuitive sense so that even if you eat the wrong thing, you don't beat yourself up …*
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> *I'm trying to take this high-tech movement and swing it back to using the information to get you to identify when you are ready to do something you're not yet ready to do. A good example would be a heart rate monitor. I train with a heart rate monitor …*
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> *Now, after years of using one, I know what my heart rate is at different levels. In fact, the only reason I ever used a heart rate monitor after the first couple of years was to keep me below a certain level [of exertion], because I knew if I went above a certain level, I was in that black hole of [over]training."*

How a Heart Monitor Can Improve Your Endurance

Sisson has a counterintuitive recommendation and approach to endurance training. While 220 minus your age is your theoretical max heart rate, Sisson recommends using 180 minus your age. This formula gives you your maximum aerobic function. What this means is that that's the heart rate at which enough oxygen is being put through your body to fuel fat burning, and to not put you into glycogen or sugar burning.

> *"A lot of people say, 'I'm 40 years old. That means I have a max training heartrate of 140. But Mark, I can train at 160 and 165 all day long. I could run*

six-minute miles. And when I do what you say, and I train at 140 as a max heartrate, I'm doing nine-and-a-half- to 10-minute miles. I'm almost walking. That can't be accurate.'

My response is, 'It's entirely accurate. Here's the issue. You perform well as a sugar burner. You're a great sugar burner. When you are training at 165 or 170 heart rate and you feel pretty good about it, you're great at burning sugar. But you suck at burning fat. The fact that you suck at burning fat is demonstrated by the fact that you can't do much work at 140 beats a minute.'

How Mark Allen became the premiere Ironman in the world is because Dr.[Phil] Maffetone coached him … [to keep] that metric. They go for long periods of time, never exceeding that heart rate … They don't use speed or miles per hour to dictate how fast they're going.

Over time, what they find is they become more and more efficient at that heartrate. All of a sudden, those nine-and-a-half-minute miles become eight-and-a-half-minute miles, and then eight-minute miles, and then seven-minute miles.

The next thing you know, this guy who's 40 years old complaining about how slow he's going, if he's done it for several weeks, he's all of a sudden going, 'Mark, I'm running six-minute miles at 140 beats a minute. Imagine what I can do when I get in a race and then I'm throttling it up at 160 or 165 beats a minute.'

At six-minute miles at 140 beats a minute, we know based on how hard the heart is not working, that he's burning fat, because he would not be able to supply that much oxygen to fuel that amount of work on sugar.

You have to understand the science. But when you do, and you realize as long as you're willing to spend time in this zone, you become more and more efficient. That is what endurance is all about. It's about how efficient you are."

More Information

For more fitness, diet and health tips, check out Sisson's blog on **marksdailyapple.com**. There you can also find his books, which include "The Primal Blueprint," "The Primal Connection," "Primal Endurance" and "The 21-Day Total Body Transformation." If you subscribe to his newsletter you get a free copy of his fitness e-book.

His latest book, "**The Keto Reset Diet**," is available on Amazon and **ketoreset.com**. Sisson also sells whey, collagen protein, unsweetened organic ketchup, mayonnaise and salad dressings made with avocado oil on **primalkitchen.com**.

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