Dietary protein: amount needed, ideal timing, quality, and more.

| A podcast with Peter Attia, MD and Don Layman, Ph.D.

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This is loose, edited version of the show notes from this podcast. It is well worth listening to.

Don Layman is a Professor of Food Science and Human Nutrition at the University of Illinois Urbana-Champaign. He has spent the past 40 years investigating the role of dietary protein in muscle protein synthesis.

In this episode, Don describes how his decades of research have shaped his thinking around protein, muscle, anabolic factors, metabolism, and more. He explains the recommended dietary allowance (RDA) for protein: what it is, how it came about, and how it should serve only as a guide for the minimum protein necessary for survival rather than as an optimal level of protein intake. He provides an overview of the essential amino acids, explains the nuances of animal versus plant protein, and provides insights for determining protein quality, absorption rates, and how to best track your intake.

He discusses the ideal timing of protein intake in relation to resistance exercise, how protein should be distributed among meals, and how limitations in protein utilization per sitting can impact those

Don coined the concept that his colleague, Dr. Gabrielle Lyon and he always use– ***muscle centric nutrition.*** If you keep muscle healthy, you've got a good shot at avoiding obesity, avoiding diabetes, avoiding cancer, etc.

Details about muscle

Peter notes that muscle is our largest sink for glucose. 75-80% of our glucose storage capacity exists within skeletal muscle. Muscle is also an early depot for excess adipose tissue. Once we start to let little droplets of fat accumulate within muscle cells, it leads to this process of insulin resistance. This creates a problem in that it makes it harder for muscle to accept carbohydrates. This leads to hyperglycemia and ultimately diabetes.

Peter spoke with Jerry Schulman on the podcast about 2 years ago. His paradigm was the accumulation of diglycerides within actual myocytes, (not interstitial or in between the cells) is behind the development of metabolic syndrome.

The actual accumulation of lipid within muscle cells impairs insulin signaling resulting in decreased PI3K activation. This removes the signal needed to move the glucose transporter GLUT4 to the cell membrane (and glucose is not taken into the muscle cell).

Don's favorite amino acid is leucine. This is the amino acid that really got him interested in protein. In metabolism, leucine is a signal for the body to do muscle protein synthesis. All the amino acids have this building block function for making proteins where they get strung together, but they also have other metabolic functions. In the case of leucine, one of the branched chain amino acids, a main metabolic function is to signal when enough protein has been consumed at a sitting to start doing tissue repair and maintenance, and muscle building.

Don's summary: "We now know that protein handling (the efficiency) goes down as we get older. So now we have much higher requirements that most of us talk about for adults."

Peter's takeaway:

- We consume carbohydrates virtually exclusively for their energy content
- Fat, mostly for its energy content
- There is some structural importance that comes with fat and cholesterol
- In contrast, you don't want to be consuming protein for energy

Don adds a caveat, "There might be reasons that people are hypersensitive to carbohydrates where taking in more protein (beyond what you might need for protein metabolism) might be a substitution for carb calories."

If you're looking at animal source proteins, whether it's meat or eggs or milk, basically all the amino acids that a human would need are in those foods. In meat, all the amino acids are in the right balance. We have basically the same amino acids, the same protein. But every protein has a little different balance of essential amino acids.

We typically think of animal protein as:

- Mammals- beef, pig, etc.
- Bird protein, mostly chicken
- Fish protein
- And then you have eggs and dairy

The first 3 are the same for a protein, "So whether it comes from a cow or a pig or a chicken or a fish muscle, protein is still muscle protein."

How do we think objectively about the quality of a protein?

Isn't there an efficiency of that protein versus tofu versus soybean versus price all the way down to lower and lower protein density foods?

Digestion and absorption is usually 95% or higher for all animal proteins. For plant proteins it is less, maybe only 60-70% available because we can't digest the fiber associated with the proteins. You need to realize that in a plant, the protein is there for the purpose of the plant, and it is attached to fiber. When you eat plants in a raw form, only 60-70% of the protein is available because we can't digest the fiber.

mTOR Activation

"Mammalian target of rapamycin" (mTOR) is the signal that gets activated by leucine. Signaling is also activated by other amino acids, insulin, and growth factors.

Regarding previous discussions of rapamycin- people listening may be confused. If rapamycin is good and rapamycin inhibits mTOR, how can leucine be good if leucine activates mTOR? The difference is chronic activation versus acute or episodic activation. Sometimes you want mTOR on, sometimes you want it off. When we're talking about eating, you want to be able to turn on mTOR for muscle protein synthesis. You also want it turned on when there are enough amino acids to do repair, maintenance, and building. What you don't want is chronic activation due to excess insulin.

Why would raising the level of methionine and lysine to the level of leucine become a great proxy for overall protein load?

If you look at limiting amino acids in food, lysine is always ***limiting in grains***.

Lysine is probably limiting for protein synthesis. Lysine is the base to make carnitine and some other things, but it's mostly needed for protein synthesis. We need 3.4 grams of lysine per day.

We probably need a little less than 1 gram of methionine per day. Methionine is part of what we call the one-carbon pool.

We need methionine to:

- Make and repair DNA
- Make and repair RNA,
- Make taurine (downstream)
- Make the non-essential amino acid cysteine
- Make the oxidant glutathione

Methionine is one of the most limiting amino acids and it's ***limiting in all legumes*** such as soy, peas, and lentils. We think of these as higher quality protein (they are), but they're still limiting in methionine.

Natural sources of food high in methionine

Eggs are quite high in the sulfur amino acids (which are methionine and cysteine). All animal products are adequate in them All plant products are low in them. If we just ate plants, it's hard to get enough essential amino acids.

Ruminant animals can digest all that plant material and form it into appropriate amino acids…. So basically, for every 60 grams of plant-based protein the animal eats, they'll make 100 grams of essential amino acid balanced protein. This is why ruminants are called up cyclers.

Whether it's in dairy or meat (cow, goat, sheep, deer), **all ruminant animals upcycle by eating grasses and produce great quality protein.**

Peter asks, "The bacteria are obviously the engine of that upcycle, but you can't make nitrogen out of nothing. So, you're saying…?"

They're making protein out of nitrogen; they're getting inorganic nitrogen from plants. Ruminants are able to increase the value of non-amino acid nitrogen, plus they capture the nitrogen in protein form.

Peter has never heard of this phenomenon and asks, "Are they also disproportionately creating amino acids that weren't necessarily there in the plant?"

That is exactly what is happening.

Bacteria/ flora in the cow will produce methionine or lysine. They can take glycine (a non-essential amino acid) and make it into any other amino acid. One supplement you feed cows is urea and they can make it into methionine or leucine or lysine.

Peter finds this fascinating and notes, "Now we're venturing from nutrition into religion, because there's certainly a group of people who would argue that we should not be eating any animal protein whatsoever… A counterargument to that would be, it's awfully difficult without these animals to get adequate amino acids."

Don thinks of it as a biochemist and someone who grew up on a farm where they raised cattle, pigs, corn, and soybeans. He sees it as a life cycle type of thing. There's no question that ruminant animals play a very important role in our food system, and one we can't really replace.

Don adds, "We can't just idle millions of acres of grassland and pretend that we can grow avocados on them or broccoli. Cattle basically spend a year of their life on basically nothing but grass. Sheep, and goats are the same, but those are amazing contributions to our food system."

Age-related changes in protein requirement

Don mentioned differences in the efficiency of muscle protein synthesis between a 20-year-old and a 60-year-old.

Peter asks, "What do we know about a 20-year-old versus a 60-year-old who puts their muscle under a progressive overload? They're doing resistance training. They're being provided with adequate amino acids, and let's assume they're being provided with not just the right quantity but the right quality of amino acids."

Don begins with the need for protein turnover, "It's important to recognize that whether you're 16 or 65, your body needs to make nearly 300 grams of new protein per day." Every tissue in the body is turning over. Some turn over as fast as liver enzymes, where you replace them every hour.

For muscle proteins the half-life is around 15 to 16 days. Every 30 days collagen turns over which is why if you hurt your knee, it takes so long to repair it.

The body replaces literally every protein in it, about 4 times a year, and that's a remarkable number. We have to make 300 grams of new protein per day, but the average American intake is around 80 grams or less (for women it's 70 and for men it's 90). This means recycling is going on. For every new protein that's getting made in the body about 6 out of 7 amino acids are being recycled. This feeds into the process of protein synthesis and protein turnover.

In Don's master's degree he was studying age-related changes in protein synthesis. We now know that as you get older, the efficiency of protein turnover goes down. If you give a 16-year-old a certain amount of protein, they will have a very good response. A 65-year-old may have 10% of that response or no response at all.

Don's summary:

We have learned, with the study of leucine and initiation factors and all of that, that if you give an enriched source of essential amino acids, you can make the adult look just like the 16-year-old in terms of their response to protein intake. What we know is that the efficiency goes down, but the capacity to respond doesn't. **Current thought in the field is that if you have a dietary protein requirement that's about twice the minimum RDA (2 x 0.8 = 1.6 gram per kg), you can get the 65-year-old to respond the same as the 20-year-old in terms of muscle protein synthesis.**

Peter recalls the earlier discussion of how it's a slippery slope if you just focus on total protein. If a person says, "I'm 65 years old and I'm on a plant-based diet," does their protein intake need to be higher?

Don says this point is exactly right.

We know is that most people who go to a plant-based diet, a vegetarian diet, decrease both the quantity and the quality of protein that they take in. If you're on a plant-based diet you'll need more protein, and that means you'll have to have more calories.

What is the threshold?

If you have 100, 120 grams of protein per day, the distribution between animal and plant probably doesn't matter, because you probably have enough to cover it. But if you're only eating 50 grams of protein per day then it makes a big difference. You'll never catch up to your essential amino acid needs.

A good target is somewhere between 50 and 120 grams of protein, it depends on what you choose. If you're going to be plant-based, have 125 grams of protein per day and you're probably fine. But you're going to get in trouble if you're going to be vegetarian and you think you're going to get along with 56 grams per day.

What explains anabolic resistance?

1st and foremost are hormones. When you're growing, hormones are your friend; they are driving it. If you look at malnutrition in Africa, children will grow on really lousy diets. They may not grow to be as healthy, they may not live as long, but there's a survival/ reproductive nature to that.

Now consider healthy aging and the criteria are different. Let's think about mTOR in that framework

There are 4 different signals that regulate mTOR

- Leucine
- Insulin
- An enzyme factor known as AMP kinase, which senses when energy drops in a cell.
- Another molecule known as REDD1, which is stress sensitive, particularly to resistance exercise.

These are 4 different things the individual balances. The hormone that is dominant to drive growth when you're young is insulin, and IGF-1 drives the process. Insulin is a growth hormone. When you stop growing at 25, insulin ceases to influence protein synthesis and muscle growth.

At this point the whole thing shifts to protein quality. Protein quality is not nearly as important when the system's dominated by hormones.

As we get older, we can buffer that loss of the hormones by higher quality protein, mostly leucine, and with resistance exercise. That's the way you have to think about the change in efficiency that occurs with aging.

One of the challenges Peter has with patients is when they get into a very heavy regimen of time restricted feeding. The idea is they limit the amount of time they eat but don't place any limits on what they eat, how much, or what they're eating from. It certainly is an effective way to reduce calories. Peter has seen in people who adopt a very narrow feeding window (1 meal a day) for 6 months, they disproportionately lose lean tissue. The diagnosis here is straightforward– they clearly reduced energy intake, but they probably reduced protein intake too much. Body composition got worse, despite the fact that weight went down.

Can you eat all your protein in one meal?

Peter asks, “Even if I was able to eat 150 grams of protein in one sitting, is it clear that my body will get the benefit from that, that it would if I ate 50 grams three times a day?”

Don replies, “It’s quite clear that you won’t get a benefit, that there is a limit.”

There is a lot of data now that muscle can handle protein meals for an optimum anabolic response between 25 and maybe 60 grams before you start using the protein for uses other than making protein.

One of Don’s pet peeves in nutrition is when people refer to protein as a percent of calories. Protein is not a percent of calories. The protein requirement is an absolute number.

You need to decide on what you’re going to build your diet around. For Layman, it is key to get the amount of protein right as a baseline and then consider the rest of the diet.

Protein requirements are an absolute number so if your calories go down, your protein intake should remain the same. For example, if 75-year-old woman’s calories go down to 1200 calories/day, she still has a 100 gram per day protein requirement. So now her protein needs are 35-40% of her calories.

When people are doing weight loss, it’s important to remember, again, that protein requirements are an absolute number and not a percent of their daily calories.

It’s common for people to say the diet should be 30% fat, 50% carbohydrates, and that leaves 15% for proteins. This is not a good way to think about this. You have to think about protein first.

Timing of your protein foods

As far as distribution of protein, his research shows that “the most critical meal of the day is the first meal of the day.”

When you have had an overnight fast your protein synthesis is down and that mTOR signal molecule is down regulated (it’s inhibited), and until you have enough leucine (around 3 g, which translates to about 30 g of protein for most people), your muscle stays catabolic. Muscle is being broken down.

Don thinks that’s a significant aspect of aging, that people have lower and lower protein intake, they don’t eat protein at breakfast, and we know the efficiency is going down in the first place.

We want to front load protein during the day. We want at least two meals that are well above 30 g of protein. He always has people shooting for 40/45 g at the first meal, and another 45 at their last meal. And then in-between, if we’re talking about a person who is elderly and trying to maintain at least minimal muscle mass, he’ll concentrate on those 2 meals.

For someone who's trying to lose weight, he suggests 3 meals with 40-45 grams because he doesn't want them getting hungry.

For someone who's trying to build a lot of muscle, he suggests 4 meals with 40-45 grams.

The data show for absolute certain that the first and last meal are absolutely the most important meals of the day for building and maintaining muscle mass. Don would be hard-pressed to find a study where anybody's ever looked at lunch.

The reason a muscle builder person needs 4 meals:

- The leucine effects on mTOR signaling for muscle protein synthesis
- To get enough total protein per day

If you want more protein to build more muscle, with an effective max out at 50 g of protein at a sitting, you need another meal to get more in during the day.

What about the timing of protein intake in relation to exercise/ strength training? There is debate about this. You will find people and trainers who want to eat protein before a workout. Don did some animal studies on this looking at different timing. He found that that exhaustive exercise is catabolic no matter what you do with food before or after the workout.

He finds the greatest benefit is after the exercise, not before.

Peter asks, "Just to be clear, what you're saying is, look, you can take all those amino acids before but it's not going to prevent you from becoming catabolic during exercise?"

Yes

Because exhaustive exercise is a catabolic activity, so you are going to be breaking down muscle no matter how many amino acids are on board while lifting. It's more important after the lift that you have a good meal. Don notes that you'll find disagreement with that in the literature, but he strongly believes this, and his research supports this.

Children will be very efficient at maintaining growth with small snacks of eight to 10 grams of protein, where that will have virtually no impact for an older adult. A protein bar that had 10 g of protein is a perfectly legitimate snack for a child.

Differences in protein requirements for children and adults and when that protein is consumed

In the adult, say they eat 100 g of protein in a day but take it in very small meals. For example, 15 g trickled in here and there all day long. This will never stimulate muscle protein synthesis. But their liver will be perfectly fine. Your gut, liver, heart, kidneys, will all respond to the net protein per day, no matter when you ate it. Muscle is different. It is specific. Muscle isn't triggered unless the diet is exactly right. The muscle senses energy, insulin, and protein before it triggers muscle protein synthesis. If all of those aren't balanced it won't trigger, but your liver will.

Peter notes, "Teleologically you might make the case that the liver has more concern for the brain than the skeletal muscle, and maybe it gets priority over being happy because it has to maintain glucose homeostasis. And without glucose homeostasis the brain would literally die within 20 minutes."

Don agrees, "Your liver, your heart, those have to function. In the middle of the night, your liver still has to be making protein, but your muscle doesn't. "While you're lying there in bed,   your muscle is catabolic and it's supplying amino acids so all those other organs work.

Long-term, your overall health is determined by keeping the muscle healthy because it keeps everything else healthy.

Is the reason that it's okay for kids to be eating much smaller amounts of protein, is it simply just the mass?

Peter's youngest weighs 25 kg

He probably doesn't need more than 40 g of protein a day. For him to have a 10 g serving, this is 25% of his protein. For Peter 25% of his daily protein is 40 g. Don points out that for children, their protein synthesis is driven by hormones. This is not true for adults. Growth in children is highly efficient, it's driven by hormones, and children will accommodate protein in small doses.

More on timing of protein in relation to exercise

With research, what was found was that when you come out of an exhaustive exercise, muscle is catabolic until you take in enough leucine to reverse it. They started looking at feeding right after exercise. What are the caveats? There is a 2 hour window right after exercise where you can see the biggest effect of feeding, but this is in untrained individuals.

If you look longer term, you can have a bout of resistance exercise and you'll detect a difference. You'll start regulating that REDD1 protein factor. You'll see an anabolic effect the next day (24 hours, 36 hours later). The more trained you get, the less you're going to see a post-exercise effect.

If you're beginning training and you're in the first 4 weeks, post-exercise protein probably makes sense. If you're well trained, you're basically training the same way and you've been doing it for 6 months, Don doesn't see any effect difference between having protein within 2 hours after exercise versus just having your 3-4 four meals per day. You won't see any difference in either mass or strength.

Peter remembers having this discussion with Layne and being pleasantly surprised to learn– once you get to a point where you're well trained enough, you don't have to be so maniacal about meal timing. You can just focus on the big picture, which is: total protein, protein quality, and spreading it out such that you don't exceed the metabolizable fraction of it at any one sitting.

Don agrees

How much protein can muscle use at any one sitting?

Don hears trainers take that last statement about metabolizable energy and say "Well, you can't use more than 30 grams at a meal. You won't digest it." That's not true. You'll digest and absorb 100 grams of protein at a meal. But muscle in particular only has a window of around 25 to 60 grams (depending on protein quality) that it can use. The liver will use all of it.

We have what is known as first pass metabolism of protein (which confuses the issue even more). When you eat a meal of protein, approximately 50% of the protein is degraded to nitrogen and carbon before it ever gets to the blood. The exception to that are the branch chain amino acids: leucine, isoleucine, valine, where almost 75 to 80% of those get into the blood.

Now we're back to the teleological argument, "Why did muscle learn to sense that?"

Because that basically shows up in the blood in direct proportion to the meal and the muscle learned to sense that as meal quality. **This is a signal that a meal has adequate quality for muscle to trigger the very expensive process of protein synthesis, and protein turnover. And until muscle sees that signal, it won't do it.**

The other thing Peter has learned recently that surprised him is the importance of leucine in fatty acid oxidation by the muscle. One of the pillars of his practice is low-end aerobic training (zone 2). This is important for mitochondrial efficiency. This is basically pushing your muscles to their maximum point at which you can keep lactate below 2 mmol. A very fit individual can generate a lot of power while keeping lactate below 2 mmol. The best in the world can produce more than 4 watts per kilo while keeping lactate below 2 mmol, and they're doing so virtually exclusively with fatty acids as fuel.

Peter will pair this type of analysis with CPET (cardiopulmonary exercise test) testing, and will look at fat oxidation rates.

Again, you will see the fittest of the fit have insanely high fat oxidation rates, they're roughly 1 gram per minute. The point being, a really good muscle doesn't just rely on glucose. A really good muscle can oxidize fats very effectively.

What role does leucine play in that?

That's a great question, one that Don doesn't think has been researched enough. Every amino acid has a different side chain, and leucine is one referred to as a branch chain amino acid. The side chain of leucine is entirely carbons, which looks a lot like a fatty acid. Leucine is one of 2 amino acids that are ketogenic. It's metabolized as a fatty acid. Leucine will also activate the CPT1 enzyme (carnitine palmitoyl transferase enzyme), which is the link for bringing fatty acids into the mitochondria for oxidation.

It gets even more complicated, in that when you have higher leucine, it begins to inhibit pyruvate from going into the mitochondria. When you oxidize a leucine, the nitrogen that comes off it is put onto pyruvate, generating alanine, and so the body begins to recycle glucose. It becomes steady state on glucose and emphasizes fat oxidation. If you overload all of that, you can make leucine inhibit carbohydrate oxidation.

If you have huge amounts of carbs coming in, and then you overload the system with leucine, you'll inhibit pyruvate oxidation. That could look like insulin resistance.

But if you look at the physiology of how it's supposed to work, under conditions where you'd be burning fat, leucine stimulates fat oxidation and spares glucose for the brain and other tissues.

So again, you really have to think about how the experiment's set up, what's getting inhibited and what's getting pushed?

Protein and weight loss diets

Don discovered this effect of leucine on muscle protein turnover and some of these metabolic things with fat metabolism. He took the leap of faith and said, "I think the underpinning of all these diets is really the protein-carb ratio and how can we manipulate that?"

He started thinking about creating a diet from a satiety standpoint. **Protein is probably the most satiating. Fat would be next. Carbohydrate the least.** They were concerned about big insulin swings. They wanted to balance out our carbs per meal. They know that if people are overweight, they tend to have big post meal carbohydrate and insulin swings where 2 hours after eating, they'll have carbohydrate lows.

He began to think that the first meal after an overnight fast is critical. He asked, "How much protein do you need?" and came up with 30, 40 grams of protein to get both satiety and protein synthesis effects.

They knew that protein had a higher thermogenic effect than either carb or fat and they wanted to front-load that effect. People argue that because of the nitrogen, protein is harder to digest and absorb, but he didn't think that was true. They thought the thermogenic effect was stimulating muscle protein synthesis, which is a massive ATP expenditure. They wanted to maximize that at every meal.

For the 1st meal they wanted 40 grams of protein, and they wanted to have a carb level that would not overstimulate insulin, so they kept the carbohydrates under 30 grams. This created a carbohydrate threshold concept. They could use fat to round out the calories.

With exactly the same calorie intake, the people on the higher protein, low carb diet lost more total weight, more total fat and less lean, and that stabilized their insulin and glycemic regulation and lowered their triglycerides across the board.

What was the difference in weight and fat mass? Was it all explained by the thermodynamics of the difference in protein? It was close. They found that the people on the higher protein diet were getting a benefit of around 170 calories a day eating the same calories. So that could be about the thermodynamic effect. Both groups lost weight (they were both on weight loss diets), but the protein people lost around 8 lbs. more and something like 6.5 lbs. of it was fat.

Did the people on the high protein diet complain less of hunger? They did a satiety check using an analog scale to ask them to rate how they felt. One of the things that the dieticians who were running the study always came back to is they said that the protein people were never talking about food and snacks, but the people on the high carb diet were always talking about being hungry and snacking. Did the results of all 3 studies point in the same direction? Yes, greater weight loss was observed in people on a higher protein diet.

Stop thinking about protein as a percent of total calories. Protein should always be an absolute amount. Then as you reduce calories, protein should have an increase in the total fraction of calories. This is going to preserve lean tissue better, maintain satiety better, and plus there's potentially this bonus of the thermogenic effect of protein.

Don adds that this definitely partitions the weight loss toward fat, protects muscle/ lean tissue, and definitely has higher satiety.

Weight loss in people over 60

For a long time there was a lot of debate over whether people over 60 should ever practice weight loss because they would lose too much lean mass (muscle) and not be able to get it back. Doug Paddon Jones had the theory that sarcopenic aging isn't a gradual decline. Instead, it's a series of acute effects where you injure yourself somehow (you're in bed; you have a surgery, whatever), you acutely lose lean mass, and you can never gain it back.

If you are a 20-year-old, it probably doesn't matter so much. But if you're older, if you're beyond 40, it does matter.

Peter just had shoulder surgery 5 months ago and he still has not gained back all the muscle mass he lost. Gaining it back has been difficult in comparison to how acutely he lost it. In 3 weeks, he was 10 lbs. lighter.

It's not just from the shoulder, it's all the things you can't do when you don't have an arm. You can't squat, you can't deadlift, etc. Some of that 10 lbs. was water weight, but 7 lbs. was lean tissue that he lost in 3 weeks.

There is a bed rest study by Doug Paddon Jones (who unfortunately passed away this last year) looking at older adults versus younger adults. In the same period of time, an older adult at bedrest will lose 4x as much muscle as a younger adult. It's frightening how fast you can lose it. If you're diligent and do weight training, you can begin to gain it back. But it's hard to get back to where you were.

It's not as important for a 20-year-old as it is for a 60-year-old. Don thinks it's a little like bone health– once you're 40, you're sort of on the back end of that, and you need to be much more careful.

Protein distribution during the day

Don did a study with Doug Paddon Jones where they took 90 grams of protein and looked at it distributed as 3 meals per day, 30, 30, 30 versus 10 20 60. They found that with the same amount of protein, the same overall diet, you would have higher net protein synthesis with the distribution of protein to breakfast. This was a study of 37-year-old (mean age). They think that by mid-thirties, you can detect the distribution effects.

Peter asks, "Just to be clear, Don, do you think that the reason 30, 30, 30 was better than 10, 20, 60, was because you started the day at 30, or because you had 3 meals where you cleared the hepatic threshold?"

That's a great question, Don thinks they would have been better off studying a protein split of 40, 10, 40. When you activate mTOR at that first meal (we know that it's still stimulated five hours later), why do you need leucine for mTOR at lunch if it's still simulated? You don't.

Nobody has studied that at this point. The key here is, "Now you're talking total protein per day, not a leucine effect. It's not a leucine- mTOR effect, there's not this threshold to it." It's total substrate

Layne (as a body builder) needs 250 grams of protein per day. He'd be better off putting that in 4-5 meals than putting it in 2. People need to understand that distributing across all the meals is *not* an mTOR effect. Distributing it this way is great for weight loss and appetite.

Thoughts on the nutritional/ amino acid composition of plant-based meats

There are a whole host of companies trying to make synthetic meat. From the little Peter has read about it, he has the impression that it will not be technically feasible from the standpoint of energetics, cost, mass balance, sanitation, and GMP.

Don thinks as the world continues to expand in population, we're going to need additional protein sources. We may be near our capacity for animal-based protein. He doesn't think we can double it again. He agrees with Peter's comments about synthetic proteins, "I don't think that will ever be economically or environmentally feasible." Popular versions of plant-based Beyond Burgers, etc. look like a flash in the pan.

Burger King's Impossible Whopper had good sales for a few months, but if you track it, it was all people who don't normally go to Burger King. Once people tried it, they never came back. The stock has fallen through the bottom now, and nobody's using it. Beyond Burger is basically a pea protein produced in Canada. It's then shipped to China, processed, and shipped back to the US. We know transportation is a #1 cause of greenhouse gas. Now it's been shipped all over and comes back to the US with around 25 ingredients, probably 5-6 are not FDA approved.

They have multiple products containing multiple synthetic components that have never really been studied and are not FDA approved. They're basically relying on safety without ever proving it.

Don's takeaway: "I think that plant-based proteins have been around a long time. I think trying to pretend that it's meat, calling soy drink milk or almond drink milk. I think those are travesties. I think those are standards of identity. Almond milk has, what, one gram protein per eight ounces where cow's milk has eight? Calling that milk is pure deception."

He's not against using them, but he thinks the consumer should be aware.

For example, if you look at any wheat cereal it has 4 grams of protein per serving. He always said that's probably only 2 grams. On the label it says, mix it with a cup of milk, and now we have 10 grams of protein. If you look at the lysine balance of that, it's exactly balanced. But if you go to soy milk, this has only 6 grams of protein per 8-ounce cup instead of 8. And it's deficient in lysine. It takes almost a quart of soy milk to balance that cereal.

If you're a mother feeding this to your child and thinking, well, I'm doing a plant-based thing and I'm feeding them a totally deficient diet with 6 ounces of soy milk for breakfast. How many mothers know that? Those are the kinds of things that we think need to come out about protein quality. We want a system where we can show people an additive value of the protein when they put that meal together.

There's a company called WISEcode that Don is working with. They think that they can use QR codes and your phone to simply add up the quality protein content and can tell what your total meal looks like. Getting enough protein and enough quality protein in the diet is hard.

"If you've got 125 grams of protein in your diet per day, chances are you'll hit those numbers. Where leucine is a meal-to-meal number, lysine is a daily number (it doesn't matter meal-to-meal, it's a total for the day)."

Peter notes for many of his female patients, it's hard to get them up to 120 grams of protein per day. Don agrees, with his studies he struggles to keep adult females at 100 grams of protein per day. Then quality becomes an issue.

This is Don's concern with the plant-based movement– do people have the resources to make it healthy? You can, but you need a lot of knowledge and food skills. You're going to have to eat synthetic products because you can’t get it from eating lentils and rice. You just can’t eat enough of them. You’re going to have to have shakes or supplements to get to that level. The track record says vegetarians end up somewhere in the 60’s for their protein per day, and quality does make a difference at that level.