Optimizing protein quantity, distribution, and quality

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Whether you are the type who eats to live or lives to eat, protein intake is a foundational part of nutritional planning to increase or maintain lean mass as you age. Dietary protein provides amino acids, which are essential for building new tissue, repairing old tissue, and conducting basic cellular functions throughout the body. In the human body, protein is formed from 20 different amino acids. Of these 20, nine are deemed “essential” because our bodies cannot synthesize them and must instead obtain them through our diet.

Unfortunately, the recommended dietary allowance (RDA) of 0.8 g protein per kg body weight per day is only the *minimum* amount of protein needed to maintain nitrogen balance and is far too low for goals of increasing lean mass and minimizing the risk of sarcopenia, especially as we age and become anabolically resistant. How much protein each individual requires is more complicated and depends on sex, body weight, lean body mass, and activity level, but essentially, if you under-consume protein, your body will use its own lean mass as a source of amino acids, leading to loss of muscle mass. The Acceptable Macronutrient Distribution Range (AMDR) is 10-35% of caloric intake as protein, which is 1.0-3.7 g/kg/d for the average 57-kg woman or 70-kg man. For those who are minimally active, the lower end of this range is probably sufficient to maintain lean mass. However, those who want to *increase* their lean mass or who partake in moderate or intense physical activity should try to consume higher levels of protein to promote strength and skeletal muscle growth, up to around 1.2-2.2 g protein/kg body weight/day.

In our practice, we aim for the upper half of this range, or about 1 g per pound of body weight (2.2 g/kg body weight/day), but optimizing your increase in lean mass through muscle protein synthesis (MPS) via protein intake is more than a matter of how much protein to eat – it also depends on how that protein is *distributed* over the course of a day, as well as on protein *quality*.

Distribute intake throughout the day

For a 175-lb person, 2.2 g protein/kg body weight/day equates to a daily intake of 175 grams, but obtaining this quantity from a single meal is virtually impossible for most of us. It would be the equivalent of eating about 30 eggs, for instance, or around 24 ounces of lean ground beef (three large, steakhouse burgers). This is, in my view, one of the biggest drawbacks of time-restricted eating (TRE) patterns, which force daily intake into narrower and narrow windows of time, making it even more difficult to reach total daily protein targets. It is far more practical to eat 3-5 meals of 30-60 g of protein each.

What might this spread of protein intake look like on a typical day? A breakfast containing 40 g protein might be: a 3-egg omelet (6g protein/egg) with an ounce of cheddar cheese (6 g) and a 5.3 oz container of Greek yogurt (16 g) with some fruit. For lunch and dinner, a 6 oz piece of salmon (34 g), 5 oz of venison (43 g), or a cup of chicken breast (38 g) along with a cup of quinoa (8 g) and some vegetables will hit the required threshold. Add a post-workout protein shake, and that's four meals that hit protein requirements.

But apart from the *difficulty* in consuming daily protein requirements in one sitting, doing so may also come with disadvantages in *optimizing usage* of ingested protein for MPS. Everyone has a maximal rate of protein synthesis (likely dependent on a person's lean mass) and thus a limit to the amount of circulating protein that can be used for anabolic processes at any given time. The influx of amino acids – and in particular, the amino acid leucine – that comes with protein ingestion serves as an anabolic signal (via mTOR activation) to ramp up MPS, but because the body doesn't have a true storage depot for protein as it does for fats (adipose tissue) or carbohydrates (glycogen), when a large amount of protein is consumed and circulating levels of amino acids surpass the amount that can be used for protein synthesis, the excesses are thought to be burned as a fuel source. Specifically, conventional nutrition wisdom holds that consuming protein in excess of ~20-30 g in a single meal does not increase maximum rate or duration of MPS and instead results in a significant proportion of the ingested protein being oxidized for energy.

Fortunately, as I discuss in an upcoming podcast with [Luc van Loon](), more recent research has indicated that at least for most protein sources, the limit is far, [far greater]() – and may not exist at all. But depending on countless variables related to the type of protein, amount of protein, and the way in which it is prepared and consumed, the *duration* of anabolic responses to protein intake might range from just 2-3 hours to most of the day. Thus, while oxidation of excess amino acids from a single meal may be less of a concern than previously thought, distributing protein intake across meals still provides an advantage in ensuring that anabolism is *sustained* throughout the day, regardless of the type of protein or manner of preparation.

Avoid too little per sitting

Research suggests distributing protein evenly across multiple meals throughout the day, but why is it better to have 3-5 meals of 30-60 g/meal than to have, say, many small 15-g protein bars throughout the day as snacks?

When it comes to using nutrition as a lever for stimulating MPS, there is a minimum amount of protein that is capable of maximizing anabolism. As mentioned above, the essential amino acid leucine stimulates MPS, but this doesn’t necessarily happen every time you eat. As discussed in my podcast conversation with Don Layman, when your postprandial circulating leucine approximately *doubles*, it signals a high-quality protein meal and triggers MPS. Studies have estimated that about 25-30 g of protein per meal is sufficient to double circulating leucine, so if each meal has a minimum of 25-30 g of protein, this will activate maximum MPS for a large percentage of the day.

It might feel easier to get your ideal total protein volume through many small protein snacks, but without hitting the threshold for MPS, the protein consumed is more likely to be oxidized for energy rather than used for protein synthesis. Consequently, if you spread out your protein across too many mini “meals,” higher daily protein consumption still won’t confer the maximum anabolism benefits.

Quantity *and* quality

While getting this quantity of protein may already seem challenging, it is also important to consider the source of your protein. Protein quality (quantified as the digestible indispensable amino acid score, or DIAAS) is characterized by the essential amino acid content and relative digestibility, or what percentage of dietary protein is absorbed. Generally, animal-derived protein sources such as eggs or milk are considered high-quality (DIAAS >100) because they have high bioavailability of all essential amino acids.

Plant-based protein sources contain all essential amino acids, but they are often limited, meaning they have a low content of one or two essential amino acids (most commonly lysine and methionine). Inadequate intake of any essential amino acid will result in deamination and oxidation of all other amino acids, so it is imperative to make sure your protein sources have sufficient lysine (3-4 g/day) and methionine (1 g/day). Grains are generally limited by lysine and legumes are limited by methionine and cysteine. This is one reason why beans and rice are a classic pairing; the essential amino acid profiles are complementary. Plant-based protein sources also tend to have lower, but not limiting, percentages of the essential amino acid leucine, around 7% compared to 9-10% in animal-based protein. The overall lower percentage of leucine means a higher level of overall protein is needed to get a daily intake of 5-7 g of leucine to signal MPS through the mTOR pathway.

Furthermore, plant-based proteins have relatively low DIAAS scores (<100), especially in their whole-food forms, because the matrix surrounding the nutrients (i.e., dietary fiber) tends to be less digestible, and thus a lower percentage of amino acids are absorbed. For example, chickpeas (DIAAS = 83) have a digestibility of about 76%, meaning that you’re only absorbing about ¾ of the protein you've eaten, and you would need to eat 33% more to reach your target protein intake. In contrast, the amino acid absorption from whey or egg whites is >99%. So if you choose to exclusively get your protein from plant-based sources, it is crucial to eat a variety of protein-rich foods that are complementary in their amino acid profiles and to increase overall daily protein intake to compensate for decreased bioavailability.

Digestibility vs. digestion rate

We can think of bioavailability – i.e., the proportion of ingested protein that is ultimately absorbed – as a protein's *digestibility*. While digestibility certainly impacts the magnitude and duration of anabolic responses to protein intake, these parameters are also determined by *digestion rate* – i.e., how quickly a given amount of ingested protein is digested and absorbed.

Generally speaking, for two protein sources of the same digestibility but different rates of absorption, the more rapidly absorbed protein will lead to a faster rise in circulating leucine levels and will stimulate a greater *initial* spike in MPS, but if you monitor long enough, the more slowly absorbed protein will eventually catch up in terms of aggregate MPS. In other words, slowly absorbed proteins result in a more extended period of anabolism. Rapidly absorbed proteins, by contrast, may more potently stimulate MPS in the short-term, but the effect is shorter in duration.

Both "fast" and "slow" proteins have limitations. Rapidly digested proteins may result in a modest increase in protein oxidation, for instance, as circulating amino acid concentrations rise quickly and achieve a higher peak level than they would with more distributed absorption. However, this concern over protein oxidation would likely only be significant for protein isolates in liquid form (e.g., whey shakes), which exhibit exceptionally rapid absorption, rather than whole-food protein sources, which take more time for the body to digest. Meanwhile, for proteins with very slow digestion rates, if a relatively small amount of protein is consumed, you run the risk that circulating leucine concentrations won't reach a level that is sufficient to stimulate increased MPS. These limitations underscore the importance of getting enough protein per serving and, ideally, distributing throughout the day to avoid the risk of increased protein oxidation.

Timing intake to maximize training benefits

Evenly distributing your protein over 3-5 meals ensures that your body has enough amino acids for building new muscle tissue. Although many believe it is critical to consume protein immediately after resistance training – during your "anabolic window" – this window is wide enough that as long as your meals are no more than 4-6 hours apart, you should still be able to maximize your ability to build muscle, even if you don't consume protein right away.

One exception to this is if you like to exercise in a fasted state, such as first thing in the morning. In this case, you will want to eat a meal with both protein and carbohydrates right after exercising. Exercising in a fasted state elevates both MPS and muscle protein breakdown, but the balance favors muscle protein breakdown unless you increase amino acid availability. The release of insulin from eating some carbohydrates with your protein further inhibits muscle protein breakdown, pushing the balance back in favor of MPS.

Not just an issue for bodybuilders

As I've repeated over and over, building and maintaining muscle mass is critical for remaining active and healthy as we age. On its own, this fact means that everyone – bodybuilder or not – should be intentional when it comes to optimal protein intake. But even beyond its value in increasing muscle mass, protein intake is worthy of a little extra attention due to two factors that increase protein demands with age. The first is that aging increases the daily turnover of protein, meaning there is a greater need for protein intake simply to replace the tissue you already have. The second factor is a phenomenon known as anabolic resistance: when you get older, a higher level of circulating leucine is required to stimulate maximum MPS. The nutrition that allows you to easily build muscle in your 20s won't be sufficient to keep building lean mass in your 50s and 60s.

That said, exercise provides a key means for mitigating the effects of anabolic resistance. Exercise, like protein intake, is a powerful signal for promoting protein synthesis. Indeed, resistance training not only acts as an anabolic stimulus on its own, it also *enhances* the anabolic effect of protein intake, while *inactivity* contributes to anabolic resistance. In other words, resistance exercise increases the level of MPS that occurs for a given amount of protein ingested, so for the goal of maintaining muscle with age, protein intake and physical activity go hand-in-hand.

The bottom line

Optimizing for total dietary protein intake alone won't maximize your muscle-building potential. Eating either too much or too little protein in one sitting will result in increased amino acid oxidation – burning protein (instead of fat or carbohydrates) for fuel. The "Goldilocks zone" of protein intake for optimizing MPS is to eat your protein in a few discrete meals throughout the day: determine the number of meals needed such that any single meal isn't likely to exceed the upper limit, while still hitting the 30-g minimum threshold to stimulate MPS. Though we can't halt the inevitable slow process of losing lean mass each year, we can minimize the risk of sarcopenia by optimizing *both* the total amount of protein and its distribution over the course of the day.

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