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Protein Intake Guide

Written by the editors of Examine.com

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How much protein do you need per day?

As with most things in nutrition, there's no simple answer. Your ideal intake of calories and protein depends on your health, body composition, main goal, and the type, intensity, duration, and frequency of your physical activity. And even taking all this into account, you'll end up with a *starting* number, which you'll need to adjust through self-experimentation.

💡 Tip: Calculating your caloric needs

Your height, weight, age, and level of physical activity all contribute to your caloric needs. There are many calorie calculators out there, but the NIH Body Weight Planner stands out. It has been tested and validated against real-world data[1] and can estimate the number of calories *you* need to reach then maintain a specific weight.

Calorie-wise, there are only three types of diets:

- A **hypocaloric diet** feeds you fewer calories than you burn. If you want to lose weight, that's the diet for you. If you want most of your weight loss to be in the form of fat, not muscle, you'll also need to get enough protein and preferably to exercise.
- A **hypercaloric diet** feeds you more calories than you burn. If you want to gain weight, that's the diet for you. If you want most of your weight gain to be in the form of muscle, not fat, you'll need to get enough protein and engage in resistance training (by lifting weights, for instance).
- A **eucaloric diet** feeds you as many calories as you burn. It is also called a maintenance diet, since your weight won't change much; but you can gain or lose fat or muscle, depending on how much protein and exercise you get.

Daily protein requirements are expressed in grams, either per kilogram of body weight (g/kg) or per pound of body weight (g/lb). Ranges in the table below reflect known individual variances.

Optimal daily protein intake for adults in grams per kilogram of body weight (g/kg)

You ▶	🧘	🧘	🧘	🎅	🤰	🤱
You ▼	⚖️	💪	📏	📏	n/a	n/a
🚶	➡️ 1.2–1.8	➡️ 1.2–1.8[a]	↘️ 1.2–1.8[a]	↘️ 1.2–1.5	≥1.8	≥1.5
🏃	➡️ 1.4–2.0[b]	↗️ 1.6–2.4[c]	↘️ 1.6–2.4[d]	↘️ 1.2–1.5[e]	unknown	unknown

🧘 Of healthy weight | 🎅 Overweight | 🤰 Pregnant | 🤱 Lactating | ⚖️ Maintenance | 💪 Muscle gain | 📏 Fat loss | 🚶 Sedentary | 🏃 Active | ➡️ Eucaloric diet | ↘️ Hypocaloric diet | ↗️ Hypercaloric diet | [a] Adding regular exercise will benefit your body composition more than merely hitting a protein target. | [b] People trying to keep their weight but improve their body composition (more muscle, less fat) may benefit from the higher end of the range. | [c] Intakes as high as 3.3 g/kg may help experienced lifters minimize fat gain when bulking. | [d] Intakes as high as 3.1 g/kg may enhance fat loss and minimize muscle loss in lean lifters. | [e] If you're overweight, fat loss should be your priority, but that doesn't mean you cannot build some muscle over the same period.

- If you're sedentary, aim for **1.2–1.8 g/kg** (0.54–0.82 g/lb). Keep in mind that your body composition is more likely to improve if you add regular activity, especially resistance training, than if you merely hit a protein target.
- If you're of healthy weight, active, and wish to keep your weight, aim for **1.4–2.0 g/kg** (0.64–0.91 g/lb). People who are trying to keep the same weight but improve their body composition (more muscle, less fat) may benefit from the higher end of the range.
- If you're of healthy weight, active, and wish to build muscle, aim for **1.6–2.4 g/kg** (0.73–1.10 g/lb). Intakes as high as 3.3 g/kg may help experienced lifters minimize fat gain when bulking.
- If you're of healthy weight, active, and wish to lose fat, aim for **1.6–2.4 g/kg** (0.73–1.10 g/

lb), skewing toward the higher end of this range as you become leaner or if you increase your caloric deficit (by eating less or exercising more). Intakes as high as 3.1 g/kg may enhance fat loss and minimize muscle loss in lean lifters.

- If you're overweight, aim for **1.2–1.5 g/kg** (0.54–0.68 g/lb). This range, like all the others in this list, is based on your total body weight (most studies on people who are overweight report their findings based on total body weight, but you'll find some calculators that determine your optimal protein intake based on your lean mass or your ideal body weight). If you're overweight, fat loss should be your priority, but that doesn't mean you cannot build some muscle over the same period. (Overweight includes obesity.)
- If you're pregnant, aim for **1.7–1.8 g/kg** (0.77–0.82 g/lb).
- If you're lactating, aim for at least **1.5 g/kg** (0.68 g/lb).
- If you're vegan or obtain most of your protein from plants, then your protein requirements may be higher because plant-based proteins are usually inferior to animal-based proteins with regard to both bioavailability and amino acid profile.

Also, note that …

- Protein intake should be based on body weight, not on caloric intake. (But caloric intake should be based on body weight, too, so the two intakes are linked.)
- Most studies have looked at dosages up to 1.5 g/kg; only a few have looked at dosages as high as 2.2–3.3 g/kg. However, in healthy people, even those higher dosages don't seem to have negative effects.

> How much protein you need depends on several factors, such as your weight, your goal (weight maintenance, muscle gain, or fat loss), your being physically active or not, and whether you're pregnant or not.

💡 Tip: Calculating your protein needs

You can quickly and easily calculate your optimal daily intake with our protein intake calculator.

Optimal daily protein intake for healthy, sedentary adults

For adults, the US Recommended Dietary Allowance (RDA) for protein is 0.8 g/kg.[2] However, a more appropriate statistical analysis of the data used to establish the RDA suggests this number should be higher: 1.0 g/kg.[3]

Note that, contrary to popular belief, the RDA doesn't represent an *ideal* intake. Instead, it represents the *minimum* intake needed to prevent malnutrition. Unfortunately, the RDA for protein was determined from nitrogen balance studies, which require that people eat experimental diets for weeks before measurements are taken. This provides ample time for the body to adapt to low protein intakes by down-regulating processes that are not necessary for survival but are necessary for optimal health, such as protein turnover and immune function.[4]

An alternative method for determining protein requirements, called the Indicator Amino Acid Oxidation (IAAO) technique, overcomes many of the shortcomings of nitrogen balance studies.[5] Notably, it allows for the assessment of protein requirements within 24 hours, thereby not leaving the body enough time to adapt. Studies using the IAAO method have suggested that about 1.2 g/kg is a more appropriate RDA for healthy young men,[6] older men,[7] and older women.[8][9]

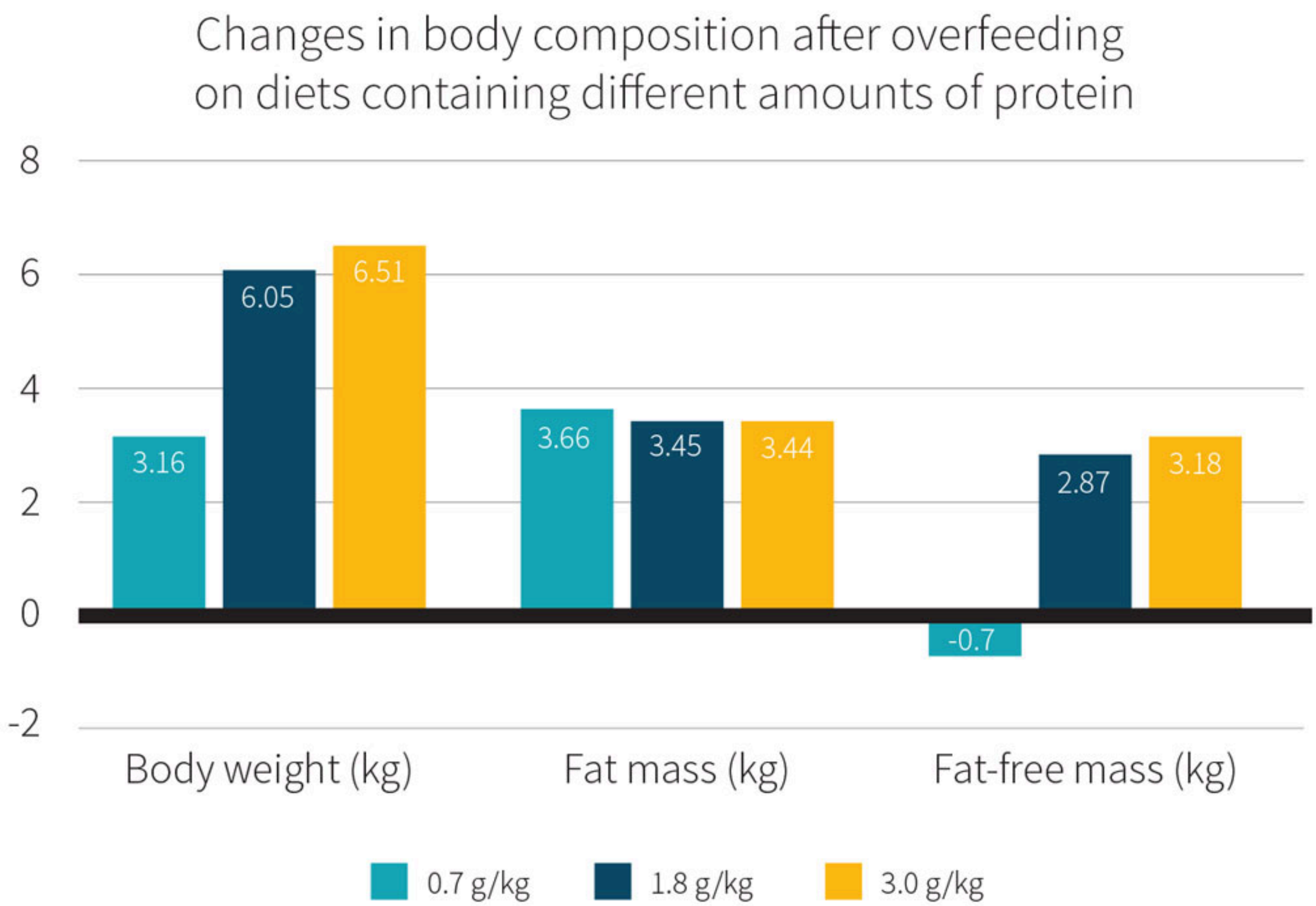
Further evidence that the current RDA for protein is not sufficient comes from a randomized controlled trial that confined healthy, sedentary adults to a metabolic ward for eight weeks.[10] The participants were randomized into three groups:

Three types of hypercaloric diets (40% above maintenance)

Macronutrients	Low protein	Normal protein	High protein
Protein (g/kg)	0.7	1.8	3.0
Protein (% of caloric intake)	5	15	25
Fat (% of caloric intake)	54	44	34

Macronutrients	Low protein	Normal protein	High protein
Carbohydrate (% of caloric intake)	41	41	41

Each diet was equally hypercaloric: each participant consumed 40% more calories than they needed to maintain their weight. Yet, as shown in the figure below, eating near the RDA for protein resulted in loss of lean mass, and while this loss is so small as to be nonsignificant, the higher protein intakes were associated with *increases* in lean mass.



Another takeaway from this study is that eating more than 1.8 g/kg doesn't seem to meaningfully benefit body composition, which makes it a good higher end for your daily protein intake, provided that you aren't physically active or trying to lose weight.

Optimal daily protein intake for healthy, sedentary adults

Body weight (lb)	Body weight (kg)	Lower end (g)	Higher end (g)
100	45	54	82
125	57	68	102
150	68	82	122
175	79	95	143
200	91	109	163
225	102	122	184
250	113	136	204
275	125	150	225
300	136	163	245

> The RDA for protein (0.8 g/kg) underestimates the needs of healthy, sedentary adults, who should rather aim for 1.2–1.8 g/kg (0.54–0.82 g/lb).

Optimal daily protein intake for athletes (and similarly active adults)

If you're physically active regularly, you need more protein daily than if you were sedentary. The American College of Sports Medicine, the Academy of Nutrition and Dietetics, and the Dietitians of Canada recommend 1.2–2.0 g/kg to optimize recovery from training and to promote the growth and maintenance of lean mass when caloric intake is sufficient.[11] This recommendation is similar to that of the International Society of Sports Nutrition (ISSN): 1.4–2.0 g/kg.[12]

Importantly, it may be better to aim for the higher end of the above ranges. According to the most comprehensive meta-analysis to date on the effects of protein supplementation on muscle mass and strength, the average amount of protein required to maximize lean mass is about 1.6 g/kg, and some people need upwards of 2.2 g/kg.[13] Those of you interested in a comprehensive breakdown of this study will find one in *NERD* #34 (August 2017).

However, only 4 of the 49 included studies were conducted in people with resistance training experience (the other 45 were in newbies). IAAO studies in athletes found different numbers: on training days, female athletes required 1.4–1.7 g/kg;[14][15] the day following a regular training session, male endurance athletes required 2.1–2.7 g/kg;[16] two days after their last resistance-training session, amateur male bodybuilders required 1.7–2.2 g/kg.[17]

Since higher protein intakes seem to have no negative effects in healthy people, one may want to err toward the higher amounts. For most athletes (and similarly active adults), the ISSN range (1.4–2.0 g/kg) will work well:

Optimal daily protein intake for athletes

Body weight (lb)	Body weight (kg)	Lower end (g)	Higher end (g)
100	45	64	91
125	57	79	113
150	68	95	136

Body weight (lb)	Body weight (kg)	Lower end (g)	Higher end (g)
175	79	111	159
200	91	127	181
225	102	143	204
250	113	159	227
275	125	175	249
300	136	191	272

Athletes and similarly active adults can optimize body composition, performance, and recovery with a daily protein intake of 1.4–2.0 g/kg (0.64–0.91 g/lb) and a preference toward the upper end of this range.

Optimal daily protein intake for muscle gain

Resistance training, such as lifting weights, is of course required for muscle gain: you can't just feed your muscles what they need to grow; you also need to give them a *reason* to grow.[18]

To gain muscle, most people should aim for 1.6[13]–2.4 g/kg.[19][20][21][22][23]

Assuming progressive resistance overload and a mildly hypercaloric diet (370–800 kcal above maintenance), a few studies suggest you'll gain less fat if you eat more protein (3.3 g/kg rather than 1.6–2.4 g/kg),[24][20] although one did not.[21]

What's important to understand is that a daily protein intake of 3.3 g/kg isn't likely to help you build more muscle than a daily protein intake of 1.6–2.4 g/kg. What the higher number can do is help you minimize the fat gains you'll most likely experience if you eat above maintenance in order to gain (muscle) weight.

Optimal daily protein intake for muscle gain

Body weight (lb)	Body weight (kg)	Lower end (g)	Higher end (g)
100	45	73	109
125	57	91	136
150	68	109	163
175	79	127	191
200	91	145	218
225	102	163	245
250	113	181	272

Body weight (lb)	Body weight (kg)	Lower end (g)	Higher end (g)
275	125	200	299
300	136	218	327

Hypercaloric diet. Intakes as high as 3.3 g/kg may help experienced lifters minimize fat gain while bulking.

> Athletes and active adults can optimize muscle gain with a daily protein intake of 1.6–2.4 g/kg (0.73–1.10 g/lb). For experienced lifters on a bulk, up to 3.3 g/kg (1.50 g/lb) may help minimize fat gain.

Optimal daily protein intake for fat loss

First, let it be clear that, though it is possible to lose fat on a **eucaloric diet** (aka maintenance diet — a diet that provides as many calories as you burn) by shifting your macronutrient ratios toward more protein, if you want to keep losing weight you'll need to switch to a **hypocaloric diet** (i.e., you'll need to start eating fewer calories than you burn).

High protein intakes help preserve lean mass in dieters, especially lean dieters. To optimize body composition, dieting athletes (i.e., athletes on a hypocaloric diet) should consume 1.6–2.4 g/kg,[25][26] skewing toward the higher end of this range as they become leaner or if they increase their caloric deficit (by eating less or exercising more).

Later studies have argued that, to minimize lean-mass loss, dieting lean resistance-trained athletes should consume 2.3–3.1 g/kg (closer to the higher end of the range as leanness and caloric deficit increase).[27] This latter recommendation has been upheld by the International Society of Sports Nutrition (ISSN)[28] and by a review article on bodybuilding contest preparation.[29]

Optimal daily protein intake for fat loss (if you're an athlete)

Body weight (lb)	Body weight (kg)	Lower end (g)	Higher end (g)
100	45	73	109
125	57	91	136
150	68	109	163
175	79	127	191
200	91	145	218
225	102	163	245
250	113	181	272

Body weight (lb)	Body weight (kg)	Lower end (g)	Higher end (g)
275	125	200	299
300	136	218	327

Hypocaloric diet. Intakes as high as 3.1 g/kg may enhance fat loss and minimize muscle loss in lean lifters.

Note that those recommendations are for people who are relatively lean already and trying to lose a little more fat while preserving their precious muscle mass. Several meta-analyses involving people with overweightness or obesity suggest that 1.2–1.5 g/kg is an appropriate daily protein intake range to maximize fat loss.[30][31][32] This range is supported by the European Association for the Study of Obesity, which recommends up to 1.5 g/kg for elderly adults with obesity.[33] It is important to realize that this range is based on actual body weight, not on lean mass or ideal body weight.

🔍 Digging Deeper: Why more protein for athletes?

Dieting athletes benefit from higher protein intakes, relative to their weights, than overweight and obese dieters. This can be partly explained in three interrelated ways:

- Overweight and obese individuals have sluggish metabolisms that tend to favor fat storage over protein storage (protein being stored as muscle). They usually need a greater caloric deficit to lose fat than do athletes (this rule isn't absolute, since the closer an athlete gets to essential body fat, the harder it gets to lose fat).
- Protein intake is based on total weight. Let's consider two dieters who weigh the same. If one is an already lean athlete and the other an overweight individual, the latter will get to consume a lot fewer calories. Let's say I'm an athlete consuming 3,000 kcal and 180 grams of protein (720 kcal): my diet is 24% protein. Now let's say I'm overweight and consuming 2,000 kcal and 120 grams of protein (480 kcal): my diet is also 24% protein.
- If an already lean athlete and an overweight person weigh the same, the former has more muscle and so needs more protein to maintain muscle mass.

Considering the health risks associated with overweightness and obesity,[34][35] it is also noteworthy that eating a diet higher in protein (27% vs. 18% of calories) significantly reduces several cardiometabolic risk factors, including waist circumference, blood pressure, and triglycerides, while also increasing satiety.[36] These effects are small, however, and likely dependent on the amount of body fat one loses.

Optimal daily protein intake for fat loss (if you're overweight)

Body weight (lb)	Body weight (kg)	Lower end (g)	Higher end (g)
100	45	54	68
125	57	68	85
150	68	82	102
175	79	95	119
200	91	109	136
225	102	122	153
250	113	136	170
275	125	150	187
300	136	163	204

Hypocaloric diet. If you're overweight or obese, fat loss should be your priority, but that doesn't mean you cannot build some muscle over the same period.

> When dieting for fat loss, athletes and other active adults who are already lean may maximize fat loss and muscle retention with a daily protein intake of 1.6–2.4 g/kg (0.73–1.10 g/lb). People who

> are overweight or obese are best served by consuming 1.2–1.5 g/kg (0.54–0.68 g/lb).

Quickly and easily calculate your optimal daily intake with our protein intake calculator.

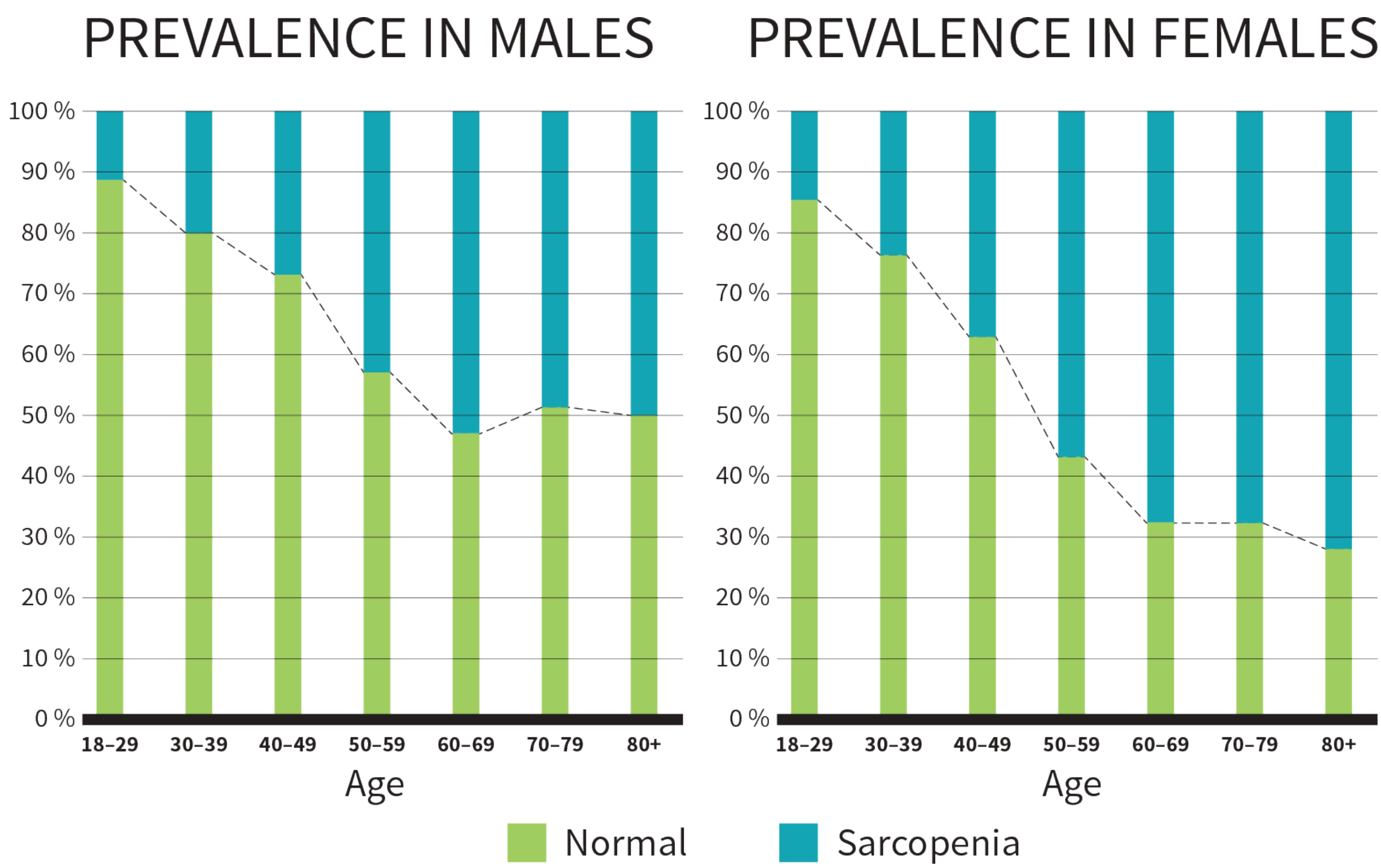
Optimal daily protein intake for older adults

Sarcopenia is a muscle disorder. It is defined as an impairment of physical function (walking speed or grip strength) combined with a loss of muscle mass.[37][38] It is the primary age-related cause of frailty.

Frailty[39] is associated with a higher risk of disabilities that affect your ability to perform daily activities,[40] a higher risk of having to go to a nursing home,[41] and a higher risk of experiencing falls,[42] fractures,[43] and hospitalizations.[44]

The link between sarcopenia, frailty, and associated morbidities may explain why sarcopenia is associated with a greater risk of premature death and reduced quality of life.[45][46] This isn't a rare issue, either: in the US, over 40% of men and nearly 60% of women over the age of 50 have sarcopenia, and more than 10% of people in their 20s.[47]

Prevalence of sarcopenia by age and sex in the US



Reference: Janssen et al. *J Am Geriatr Soc*. 2002.[47]

Fortunately, sarcopenia is neither inevitable nor irreversible — some seniors have built more muscle in their old age than they ever had in their youth. The older you get, though, the greater your muscles' anabolic resistance (i.e., their resistance to growth),[48] and so the greater the protein intake and exercise volume (of resistance training, preferably) you'll need to stimulate muscle protein synthesis.[49][50][51]

The protein RDA for adults over 50 is currently the same as for younger adults: 0.8 g/kg.[2] Same as for younger adults, however, studies using the IAAO method have suggested that 1.2 g/kg would be a more appropriate RDA.[7][8][9] Moreover, since a low protein intake is associated with frailty and worse physical function than a higher protein intake,[52][53] several authorities now recommend that older adults consume 1.2–1.5 g/kg.[54][55][56] Finally, while all adults have similar daily protein requirements,[57] older adults have higher per-meal requirements.

Notably, doubling protein intake from 0.8 to 1.6 g/kg has been shown to significantly increase lean body mass in elderly men.[58] Similar observations have been made in elderly women who increase their protein intake from 0.9 to 1.4 g/kg.[59] Even a small increase in protein intake from 1.0 to 1.3 g/kg has minor benefits towards lean mass and overall body composition.[60]

So how much protein should *you* get?

- Sedentary but healthy seniors: 1.0–1.2 g/kg (0.45–0.54 g/lb)
- Sick or injured seniors: 1.2–1.5 g/kg (0.54–0.68 g/lb)
- Seniors wishing to lose weight: 1.5–2.2 g/kg (0.68–1.00 g/lb)
- Seniors wishing to build muscle: 1.7–2.0 g/kg (0.77–0.91 g/lb)

🔍 Digging Deeper: Conflicting data?

You might have noticed that, according to the bulleted list above, **sedentary, healthy seniors** (1.0–1.2 g/kg) need less protein than other **sedentary, healthy adults** (1.2–1.8 g/kg).

Does that make sense?

No, frankly, it doesn't. Of course, not every senior suffers from sarcopenia and not every young adult is free of it, as shown in the graphic above, but the *range* for healthy, sedentary seniors should not be lower than the *range* for other healthy, sedentary adults.

This glaring discrepancy springs from our having to rely on different sets of studies — thus different data sets — for seniors and for other adults. The data sets appear to conflict because they're both incomplete, both imperfect (if they weren't, we wouldn't need more studies).

In each section of this article, we decided to stick to the most relevant data available, but if you're a healthy, sedentary senior, you can also decide to adopt the higher range we gave for other healthy, sedentary adults: 1.2–1.8 g/kg.

Daily protein intake based on *body weight* (BW)

BW	**BW**	**0.36**	**0.45**	**0.45**	**0.68**	**0.77**	**0.91**	**1.00**	**g/lb**
lb	**kg**	**0.8**	**1.0**	**1.2**	**1.5**	**1.7**	**2.0**	**2.2**	**g/kg**
100	45	36	45	54	68	77	91	100	g

BW	BW	0.36	0.45	0.45	0.68	0.77	0.91	1.00	g/lb
lb	**kg**	**0.8**	**1.0**	**1.2**	**1.5**	**1.7**	**2.0**	**2.2**	**g/kg**
125	57	45	57	68	85	96	113	125	g
150	68	54	68	82	102	116	136	150	g
175	79	64	79	95	119	135	159	175	g
200	91	73	91	109	136	154	181	200	g
225	102	82	102	122	153	173	204	225	g
250	113	91	113	136	170	193	227	250	g
275	125	100	125	150	187	212	249	275	g
300	136	109	136	163	204	231	272	299	g

Depending on their health statuses and goals, older adults (50+ years) should aim for a daily protein intake of 1.0–2.2 g/kg (0.45–1.00 g/lb).

Optimal daily protein intake for pregnant women

The protein RDA for pregnant women is 1.1 g/kg.[2] This value was estimated by adding three values:

- The RDA for a healthy adult (0.8 g/kg)
- The amount of additional body protein a pregnant woman accumulates
- The amount of protein used by the developing fetus

However, as we saw previously with non-pregnant healthy adults, the RDA may not be sufficient, let alone optimal. There's some IAAO evidence that the RDA for pregnant women should be about 1.66 g/kg during early gestation (weeks 11–20) and 1.77 g/kg during late gestation (weeks 32–38).[61][62] Moreover, a meta-analysis of 16 intervention studies reported that protein supplementation during pregnancy led to reduced risks for the baby:[63]

- 34% lower risk of low gestational weight
- 32% lower risk of low birth weight
- 38% lower risk of stillbirth

This effect was more pronounced in undernourished women than in adequately nourished women. Importantly, these values were determined from sedentary women carrying one child, meaning that pregnant women who engage in regular physical activity or are supporting the growth of more than one child may need even higher amounts.

Also, keep in mind that we can only tell you what the studies reported; we can't possibly know about *your* health and *your* pregnancy specifically. Please be sure to consult with your *obstetrician/gynecologist* (ob/gyn) before making any changes.

Optimal daily protein intake for pregnant women

Body weight (lb)	Body weight (kg)	Weeks 11–20 (g)	Weeks 32–38 (g)
100	45	≥75	≥80

Body weight (lb)	Body weight (kg)	Weeks 11–20 (g)	Weeks 32–38 (g)
125	57	≥94	≥100
150	68	≥113	≥120
175	79	≥132	≥141
200	91	≥151	≥161
225	102	≥169	≥181
250	113	≥188	≥201
275	125	≥207	≥221
300	136	≥226	≥241

> Pregnant women may require a daily protein intake of at least 1.77 g/kg (0.8 g/lb) to support both the fetus and themselves. Protein supplementation during pregnancy appears to lower some risks for the baby — including the risk of stillbirth — especially in undernourished women.

Optimal daily protein intake for lactating women

As with pregnancy, there is little research investigating how lactation and breastfeeding affect protein requirements.[64] Women produce a wide range of breast milk volumes, regardless of their energy status (i.e., milk production is maintained even among underweight women — i.e., women with a BMI under 18.5).[65] The infant's demands appear to be the primary regulator of milk production.[66][67]

Based simply on adult protein requirements plus the protein output in breast milk, the RDA for lactating women was set at 1.3 g/kg.[2] However, one study reported that half of the lactating women consuming 1.5 g/kg were in negative nitrogen balance,[68] while another study suggested that 1.0–1.5 g/kg leads to a rapid downregulation of protein turnover suggestive of an adaptive response to insufficient intake.[69]

Considering (1) the lack of data on the effects of a protein intake greater than 1.5 g/kg in lactating women and (2) that consuming 1.5 g/kg or less leads to adaptations suggestive of insufficient intake, lactating women should aim to consume *at least* 1.5 g/kg of protein daily.

Optimal daily protein intake for lactating women

Body weight (lb)	Body weight (kg)	Protein intake (g)
100	45	≥68
125	57	≥85
150	68	≥102
175	79	≥119
200	91	≥136
225	102	≥153

Body weight (lb)	Body weight (kg)	Protein intake (g)
250	113	≥170
275	125	≥187
300	136	≥204

> Lactating women should aim for a daily protein intake of *at least* 1.5 g/kg.

Quickly and easily calculate your optimal daily intake with our protein intake calculator.

Optimal daily protein intake for infants and children

Optimal daily protein intake for infants and children in grams per kilogram of body weight (g/kg)

	Infants (preterm)	Infants (0–6 months)	Infants (7–12 months)	Toddlers (1–3 years)	Children (4–13 years)
Sedentary	3.0–4.0	≥1.5	≈3.0	3.0–4.0	≥1.5 g/kg
Active	n/a	n/a	n/a	n/a	unknown

Optimal daily protein intake for infants

Healthy infants

The *adequate* protein intake of healthy infants **aged 0–6 months**, based on their average weight and milk intake, is 1.52 g/kg.[70]

The *average* protein intake of healthy infants **aged 7–12 months** is estimated at 1.6 g/kg,[71] assuming that half their protein comes from breast milk and half from complementary foods. Yet the RDA is set at 1.2 g/kg for this age group based entirely on studies conducted in toddlers and children.[72]

Preterm infants

Preterm infants need to be fed enough protein to promote growth rates similar to those observed in healthy fetuses growing *in utero*. The following daily intakes have been recommended based on gestational age:[73]

- 3.5–4.0 g/kg (less than 30 weeks)
- 2.5–3.5 g/kg (30–36 weeks)

- 2.5 g/kg (more than 36 weeks)

Moreover, a systematic review by the Cochrane Collaboration reported greater weight gain and higher nitrogen accretion in preterm infants whose protein intake was 3.0–4.0 g/kg, compared to lower daily intakes.[74] These findings were echoed by another systematic review of 24 clinical trials.[75]

Since breast milk doesn't contain enough protein to meet these requirements, complementary supplementation is standard practice.[76][77]

Formulas

Breast milk is considered the optimal source of nutrition for infants (0–12 months old) and is recommended as the exclusive source of nutrition for non-preterm infants aged 0–6 months. However, not all infants can breastfeed. Infant formulas provide an alternative, but there are considerable differences in composition from breast milk.[78] One such difference is the protein content, which tends to be higher in formula.

Compared to exclusive breastfeeding, formula feeding is associated with greater increases in fat-free mass throughout the first year of life. Fat mass and body fat percentage tend to be lower during the first six months, but play catch-up afterward and ultimately end up higher with formula feeding than with breastfeeding.[79]

An association was found between formula feeding, faster growth during infancy, and obesity in childhood, adolescence, and young adulthood.[80] Some researchers suggested that the higher protein content of infant formulas was responsible,[81] but others have argued that there are too many contributing factors (e.g., breastfeeding helps infants learn to better regulate their energy intake) to single one out.[82]

Moreover, if the higher protein content of formulas were responsible for the infants' accelerated growth, then how could we explain the similar growth of infants fed formulas containing 1.2 or 1.7 grams of protein per 100 milliliters,[83] or formulas containing 1.0, 1.3, or 1.5 grams of protein per 100 milliliters?[84] (For reference, breast milk contains about 1 gram of protein per 100 milliliters.)

Still, even if consuming more protein from formulas than would be obtained from breast milk is not necessarily detrimental, it doesn't appear to confer a benefit. There is no good reason to stray from the nutrient composition of mother's milk during infancy, unless dealing with a preterm infant.

Meat

When complementary foods are introduced to infants during the latter half of infancy (7–12 months), there may be a benefit to more protein from meat.[85] Compared to feeding cereal grains alongside breast milk (total protein: 1.4 g/kg/day), feeding pureed meats alongside breast milk (total protein: 2.9 g/kg/day) was shown to lead to better growth without excess fat gain.[86]

Another study demonstrated that, as a complementary food, meat led to more favorable growth patterns than dairy (higher length-for-age and lower weight-for-length) by 12 months of age[87] — differences that persisted at the age of 2 years.[88] Both the meat group and the dairy group consumed the same total protein (3.0 g/kg).

> During their first six months, healthy infants should consume at least 1.5 grams of protein per kilogram of body weight per day (≥1.5 g/kg/day). This intake can be achieved exclusively through breastfeeding. From age 6 to 12 months, they should consume around 3.0 g/kg/day (and could especially benefit from using meat as complementary food). Preterm infants require 3.0–4.0 g/kg/day to facilitate catch-up growth.

Optimal daily protein intake for toddlers

The same data used to establish the RDA for infants aged 7–12 months (1.2 g/kg) was used to determine the RDA for toddlers aged 1–3 years (1.05 g/kg).[2] The average daily protein intake of US toddlers is 4.0 g/kg, with 90% of US toddlers consuming over 3.0 g/kg.[89]

There is a dearth of data for this age group. However, in toddlers aged 2 years with a total daily protein intake of 4.0 g/kg, complementary protein from meat led to better growth (higher length-for-age) than the same amount of complementary protein from dairy.[88]

> There is little research on what is *optimal*, but the *average* daily protein intake of US toddlers is 4 g/kg — nearly four times the RDA. Meat appears to be a better complementary food than milk.

Optimal daily protein intake for children

The protein RDA is slightly higher for children (4–13 years) than for adults: 0.95 versus 0.8 g/kg.[2]

This difference makes sense considering that children are still growing and need more protein to facilitate the process. As with adults, however, the RDA may underestimate true requirements.

Use of the IAAO technique in children aged 6–11 years has suggested that around 1.5 g/kg would make for a more appropriate RDA.[90] Protein requirements are likely higher in children involved in sports and other athletic activities.[91]

There are no long-term studies on optimal protein intake since it would be unethical to deprive children of the protein they need for their development and various physiologic and metabolic functions.

> Children require at least 1.5 grams of protein per kilogram of body weight per day (1.5 g/kg/day). An unknown amount of additional protein is likely required by children who are involved in sports or otherwise regularly active.

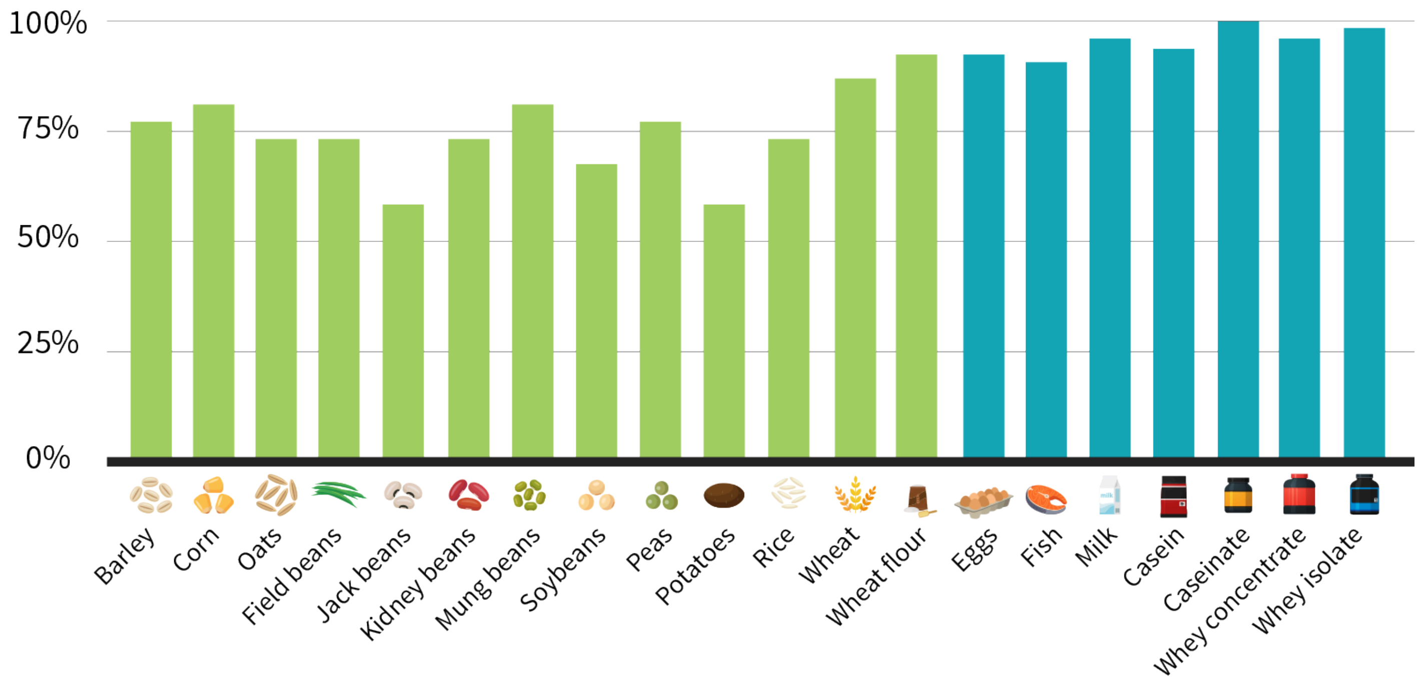
Optimal daily protein intake for vegetarians and vegans

The protein requirements discussed so far were based on studies that used animal-based protein supplements, such as whey or egg protein supplements, or were conducted mostly in omnivores. There is no reason to believe that people who get their protein mostly or entirely from plants have inherently different protein requirements, but since plant-based proteins tend to be lower in quality than animal-based proteins, if you obtain most of your protein from plants you will need to pay attention not just to the amount of protein you eat but also to the quality of that protein.[92]

A protein's quality is determined by its **digestibility** and **amino acid profile**.

Digestibility matters because if you don't digest and absorb some of the protein you eat, then it may as well not have been eaten. Animal-based proteins consistently demonstrate a digestibility rate higher than 90%, whereas proteins from the best plant-based sources (legumes and grains) show a digestibility rate of 60–80%.[93]

Digestibility of various plant- and animal-based proteins



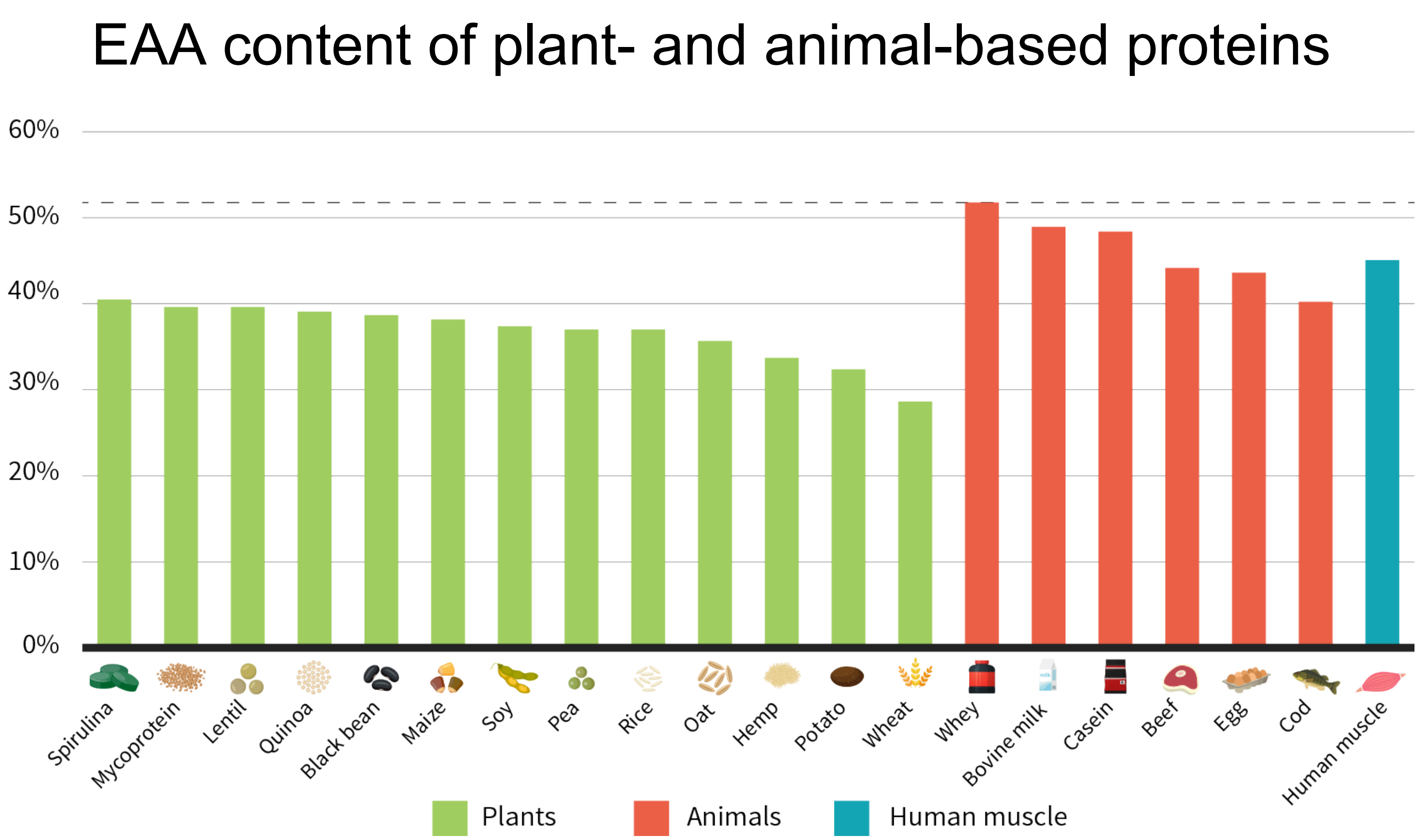
Reference: FAO. *Protein Quality Evaluation in Human Nutrition*. 2013.[94]

Plants contain anti-nutrients that inhibit protein digestion and absorption, such as trypsin inhibitors, phytates, and tannins.[95] While cooking does reduce anti-nutrient concentrations, it doesn't eliminate them entirely. Plant-based protein powders, however, are mostly free of antinutrients and so have digestibility rates similar to those of animal-based proteins.[93]

The **amino acid profile** of a protein matters because all proteins, including the protein you eat and the protein in your body, are made from some combination of 20 *amino acids* (AAs). Your body can produce 11 of these AAs, making them *nonessential amino acids* (NEAAs). Your body cannot produce the other 9, which are therefore *essential amino acids* (EAAs) you must get through food.

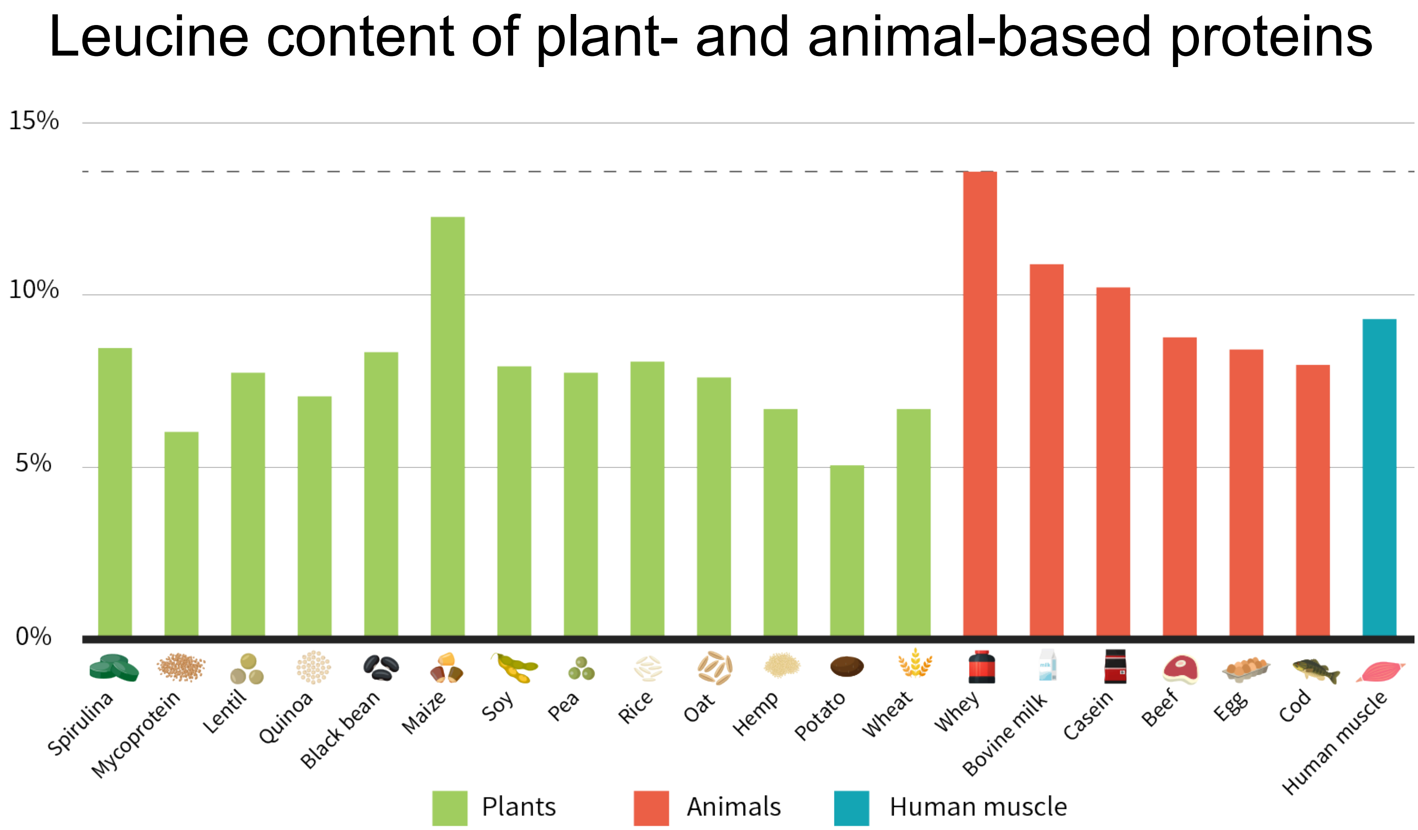
Building muscle requires that, cumulatively, *muscle protein synthesis* (MPS) exceeds *muscle protein breakdown* (MPB), resulting in a net accumulation of muscle protein. All 20 AAs are required to build muscle tissue,[96] but MPS is stimulated primarily by the EAAs in the food you ingest.[97]

Plant-based proteins, whether from whole foods or protein powders, contain less EAAs than animal-based proteins.



Reference: FAO. *Protein Quality Evaluation in Human Nutrition*. 2013.[94]

In particular, plant-based proteins are lower in the EAA leucine, which is believed to act as a signal to “turn on” anabolic signaling pathways and MPS,[98][99] although all EAAs are required for the effect to persist.[100]



Reference: van Vliet et al. *J Nutr*. 2015.[101]

The lower leucine and EAA content of plant-based proteins helps explain why several studies have reported lower rates of MPS from soy protein powders and beverages than from whey protein,[102][103] skim milk,[104] whole milk with cheese,[105] and lean beef.[106]

However, while differences in MPS do appear to translate to differences in lean mass when modest supplemental protein doses are used (about 20 g/day),[107][108] when higher doses are used (33–50 g/day), animal-based (whey) and plant-based (soy, rice) supplemental proteins appear to affect lean mass similarly.[109][110][111][112] In short, consuming more protein overall appears to offset the lower quality of the plant-based proteins.

Plant-based proteins also contain *limiting amino acids*, which are EAAs present in such small amounts that they bottleneck protein synthesis. Lysine is the most common limiting amino acid, especially in cereal grains, such as wheat and rice.[113] Nuts and seeds also tend to have lysine as a limiting amino acid. Beans and legumes, on the other hand, contain sufficient lysine but lack sulfurous amino acids, such as methionine and cysteine. Combining different plant-based proteins can help make up for their respective deficits.

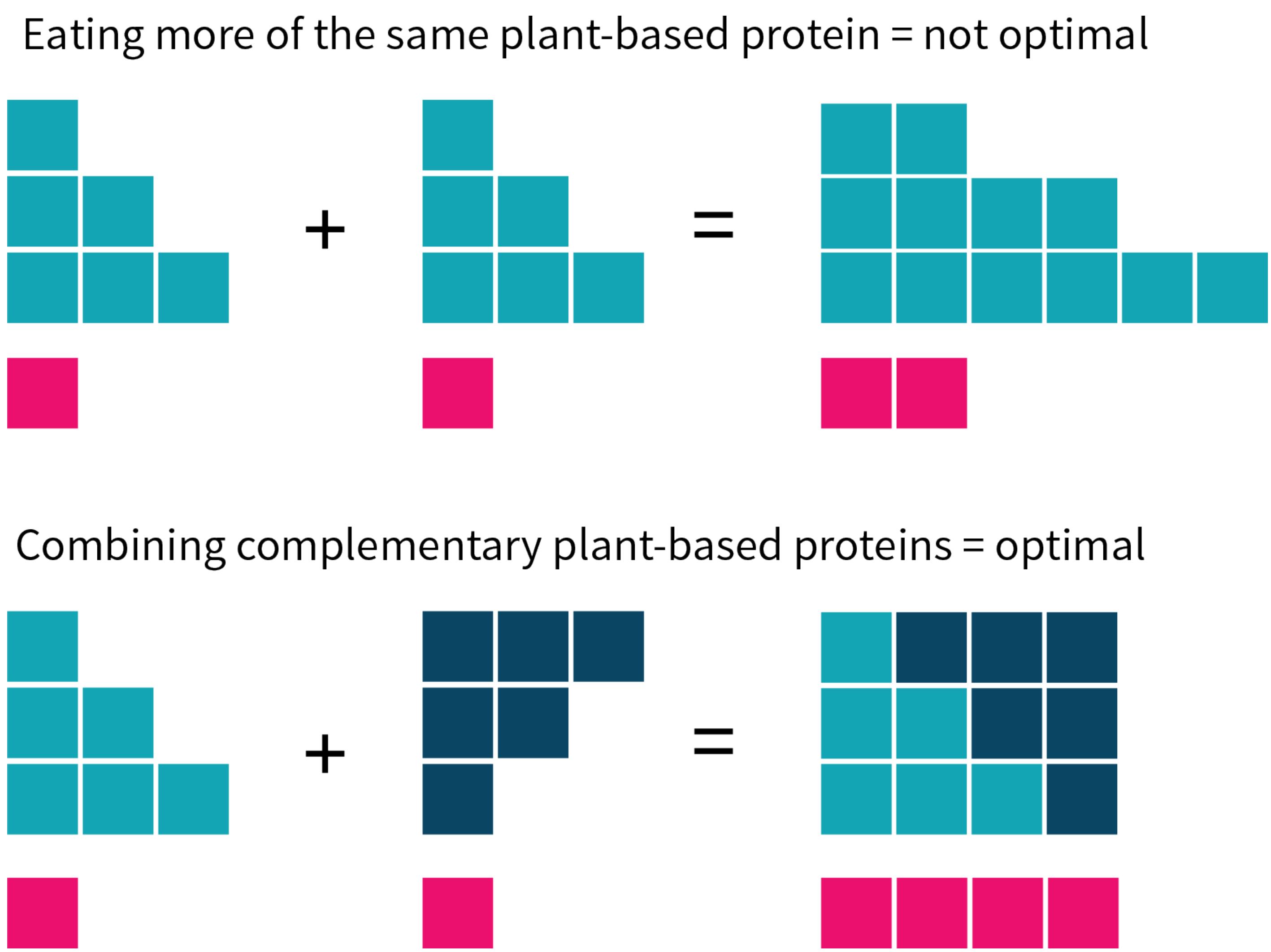
> Plant-based proteins are of lower quality (they are less bioavailable and contain less EAAs). If you get most of your protein from plants, you will need to consume more protein to achieve the same muscle growth as someone with a more omnivorous diet.

Bolstering plant-based proteins

The simplest method to overcome the EAA deficits of a plant protein is to eat more of it. As aforementioned, a handful of studies have shown that large doses (33–50 g/day) of animal-based (whey) and plant-based (soy, rice) supplemental proteins appear to increase lean mass similarly.[109][110][111][112]

Another way to overcome the EAA deficits of plant proteins is to combine complementary EAA profiles.[114] Historic examples of such combinations include beans with corn in the Americas and rice with soybean in Asia. These grain-legume combos work because legumes supply the lysine missing in grains whereas grains supply the methionine and cysteine missing in legumes.

Combining incomplete proteins



Adapted from: Woolf et al. *PLoS One*. 2011.[114]

Unfortunately, most plant proteins are low in leucine, meaning that combining different plant proteins will not have a large benefit unless one of those proteins is corn protein (whose leucine content rivals that of whey protein).

If your protein has less leucine, you need to eat more of it to maximize MPS — or you can take leucine as a supplement. MPS was increased similarly by 25 grams of whey protein (providing 3 grams of leucine) and by a combination of 6.25 grams of whey protein and 4.25 grams of supplemental leucine (5 grams of leucine in total).[115] A rodent study using plant proteins reported similar results.[116]

> The EAA deficits of plant-based proteins can be overcome by eating more, combining complementary proteins, and

supplementing with leucine.

How much protein do you need per meal?

Muscle protein synthesis (MPS) is the process of building new skeletal muscle tissue. When MPS chronically exceeds *muscle protein breakdown* (MPB), resulting in a positive net protein balance, we can expect muscle growth over the long term.[117][118] Each time you eat represents an opportunity to promote muscle growth through the stimulation of MPS.

Protein-feeding studies using various doses of whey protein suggest that 0.24 g/kg/meal will maximize the MPS of the **average** young adult,[51] whereas 0.40 g/kg/meal will maximize the MPS of **most** young adults.[119] For older adults, these two values jump to 0.40 and 0.60 g/kg/meal.[51]

Desirable minimal protein intake range per meal and age

Body weight (lb)	Body weight (kg)	20s	30s, 40s, 50s	≥60
100	45	11–18	*13–24*	18–27
125	57	14–23	*16–30*	23–34
150	68	16–27	*20–36*	27–41
175	79	19–32	*23–42*	32–48
200	91	22–36	*26–48*	36–54
225	102	24–41	*30–54*	41–61
250	113	27–45	*33–60*	45–68
275	125	30–50	*36–66*	50–75

Body weight (lb)	Body weight (kg)	20s	30s, 40s, 50s	≥60
300	136	33–54	*39–72*	54–82

The ranges in this table represent individual variations. The minimum protein requirements increase as you age, but to what degree is uncertain because of the age gap left by the studies: most subjects were in their 20s (0.24–0.40 g/kg) or 60s/70s (0.40–0.60 g/kg). For people in their 30s, 40s, or 50s, the 0.29–0.53 g/kg range reflected in this table is an educated guess. **References:** Schoenfeld and Aragon. *J Int Soc Sports Nutr*. 2018. [120] Rafii et al. *J Nutr*. 2016. [7] Morton et al. *Front Physiol*. 2015. [119] Moore et al. *J Gerontol A Biol Sci Med Sci*. 2015. [51] Rafii et al. *J Nutr*. 2015. [8]

Your mileage may vary. The ranges above are not *ideal* ranges. Instead, they cover the known extent of interindividual variations among healthy adults. In other words, if you're in your 20s, you don't need to calculate your protein intake per meal so that it falls precisely within the 0.40–0.60 g/kg range. Rather, your *minimum* protein intake per meal (to maximize MPS) is likely to fall within that range.

Further, there are at least **three good arguments** in favor of eating toward or even above the higher end of your range:

First, the ranges we listed are derived from studies using whey protein in isolation. Whey protein is highly bioavailable, rich in *essential amino acids* (EAAs), and quickly digested. When eating lower-quality or slower-digesting proteins (as would occur when eating a meal, especially one rich in plant-based foods), higher protein intakes are probably required.

Second, while these values suggest a protein-intake threshold for maximally stimulating MPS, there is no known threshold for *whole-body* protein balance.[121] For example, a study using meals with lean beef found that 40 and 70 grams of protein (0.5 and 0.8 g/kg) led to similar increases in MPS, but that 70 grams led to greater increases in whole-body protein synthesis and greater decreases in whole-body protein breakdown.[122] In other words, eating more protein may not necessarily translate to greater *muscle*-protein turnover and growth, but since muscle tissue accounts for only 25–30% of whole-body protein turnover,[123] the additional protein is not "wasted" (a common myth).

Third, as shown above in the Prevalence of sarcopenia by age and sex in the US graphic, even people in their twenties can suffer from sarcopenia — in which case they would benefit from a protein intake closer to the one recommended in this table for adults over sixty.

You may have heard that if you eat more than 30 grams of protein in one sitting, the "excess" will pass undigested, but that's just a myth. It is however true that spreading your protein intake over a few meals, making sure that you meet your desirable minimal protein intake per meal with each meal, will generally result in greater lean mass and strength. A pragmatic review article suggests that, to maximize their lean mass, active adults should consume 1.6–2.2 g/kg/day spread across four meals (0.40–0.55 g/kg/meal).[120]

> For maximal stimulation of muscle protein synthesis, aim for a per-meal dose of quality protein (such as can be found in meat, eggs, and dairy) of 0.4–0.6 g/kg. Higher doses will not be wasted and are probably necessary when eating mixed meals that contain a variety of protein sources.

🔍 Digging Deeper: Protein intake ceiling

You may have heard that you can't digest more than 30 grams of protein in one sitting. This notion of a "protein intake ceiling" derives partly from early studies that observed increased nitrogen losses in the urine with increased protein intakes. This was thought to mean that the extra protein was wasted.[124]

We now know that things aren't so simple. When you eat protein, your body doesn't use it directly; instead, it breaks it down into its constituent amino acids and uses those to make its own proteins. When you eat more protein, your body can afford to replace more of its damaged or oxidized proteins, so that your protein synthesis *and* breakdown are both increased.

In other words, eating more protein increases your body's protein turnover.[125] The raised levels of urinary nitrogen then reflect, not a waste of eaten protein, but an increase in the breakdown of your body's damaged or oxidized proteins.[126]

(Note that elevated levels of urinary nitrogen can also indicate health issues, such as problems with kidney function.)

The notion of a "protein intake ceiling" derives also from studies on the body's *muscle protein synthesis* (MPS) response to different intakes of protein.

- One study in healthy young men found that eating more than 20 grams of whole-egg protein didn’t further increase MPS.[127]

- Another study in younger and older people found that 90 grams of protein from 90% lean beef didn’t increase MPS more than did 30 grams.[128]

However, your body doesn't use dietary protein only to make muscle, or even only to make other proteins. It also uses the nitrogen from the dietary protein’s amino acids to synthesize important non-protein molecules, such as purines and pyrimidines, the building blocks for nucleic acids such as DNA and RNA.

Moreover, your small intestines are able to absorb and store a large amount of amino acids, ready to be used when your body needs them.

In short, the idea that eating more than 30 grams of protein results in wasted protein is incorrect. Your body will break down and use all the protein you eat, sooner or later, one way or another.

(Note, also, that higher protein intakes increase satiety, which is particularly helpful if you’re trying to cut calories as part of a weight-loss diet.)

How much protein do you need after exercise?

After exercising, when your muscles are more sensitive to the anabolic effect of protein, take a dose in the range of your desirable minimal protein intake per meal. If you've been exercising on an empty stomach, you'll be in negative protein balance, so take this dose as soon as possible. Otherwise, try to take it within a couple of hours — the exact size of your "window of opportunity" depends on how much protein you're still digesting.[129]

🔍 Digging Deeper: After better than before?

Is it better to eat before or after exercising?

In a 2020 crossover trial we first summarized for Exercise Personalized, 8 healthy young men were divided into three groups.[130]

All three groups performed a full-body strength workout in the morning. One group ate a meal 1.5 hours before, another just after, and the last waited for lunchtime.

This happened three times, with three days in between. Each time, the men switched to a different group. Thus, at the end of the trial, they had all tried all three meal times.

Blood insulin and certain modified amino acids were measured as indicators of muscle breakdown. **The results?** Eating a mixed-nutrient meal immediately after resistance training, rather than 1.5 hours before or not until lunchtime, resulted in the greatest suppression of muscle protein breakdown.

Whether or not this correlates with improvements in muscle growth and recovery, however, is unclear.

Getting enough protein is easier than you think

You’ve used our table or calculator to determine how much protein you need in a day, but the numbers don’t look right. Let’s say you’re 125 pounds, of healthy weight, physically active, and trying to get even leaner. You discover that your optimal intake starts at **102 grams** of protein. Isn’t that *too much* for someone so light?

So it may seem at first blush. But let’s take a step back. Let’s say you’re 125 pounds, of healthy weight, sedentary, and just trying to keep the same body composition. Your optimal intake starts at **68 grams** of protein — so **272 kcal** (less than 16% of the maintenance daily calories of a sedentary 40-year-old, 125-pound, 5’4” female). Not so daunting, now, is it?

Next, you decide to add physical exercise, in order to get even leaner. If you are 125 pounds and run at 7.5 mph (8 minutes/mile) for just ½ hour, you burn 375 kcal, compared to 41 for computer work. In other words, you burn 334 kcal more than when sitting and typing — just about the least physically demanding activity.

If you took those **added kilocalories** solely as protein, that would make 84 grams of protein. Add 84 grams to your optimal protein intake when you *don’t* exercise, and you get **152 grams** of protein — way more than your **102 grams** starting target. (Since protein isn’t the best source of energy, you could instead choose to get 102 grams of protein and 50 grams of carbs and/or fat.)

We can also calculate from the other direction. You’re 125 pounds and of healthy weight, going from sedentary to active in order to get even leaner: how will your protein intake change?

At least 102 grams of protein (active)

−

At least 68 grams of protein (sedentary)

=

At least 34 grams of additional protein

=

At least 136 additional kcal

In other words, to make **optimal** use of protein to lose fat *and preserve muscle* when you’re 125 pounds and already of healthy weight, you need to exercise so as to burn, on average, for just **136 Calories** of extra protein. If you run at 7.5 mph (8 minutes/mile) for just ½ hour and take **34 grams** of extra protein but don’t otherwise eat more than when you were sedentary and your body composition was stable, you’ll end the day on a deficit of **198 kcal**.

Even a small caloric deficit will lead to weight loss, though your body actually plays by more complicated mathematics than the ones we’ve just used. In practice, you might want to increase your caloric deficit a little, either by reducing your intake of carbs and/or fat or simply by exercising a little more.

One last thing: how can you get **34 grams** of extra protein without much extra carbs or fat? You can either take **one heaping scoop** of protein powder, probably at the end of your workout, or modify your diet so as to eat more protein (and less fat and/or carbs) over the whole day, by including more protein-rich foods in your meals.

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