

Protein Power

Answering Athletes' Questions About Protein

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Pushing protein to athletes is a multibillion dollar industry, but athletes may not get all the answers they seek from supplement companies. This article will review the current science on protein recommendations for athletes by answering their most frequently asked questions. The research on protein needs before exercise and during exercise, the best protein source, protein's effect on weight management, the timing and distribution of protein, and supplements will be reviewed to provide athletes with a "bottom line" answer. *Nutr Today*. 2015;50(2):72-77

Protein means "of prime importance," and athletes believe that protein is the most important nutrient for muscle building and sports performance. Protein's popularity is gaining with all segments of the population, not just with active people. Protein is credited with building muscle, increasing satiety, causing weight loss, and boosting immunity. It is no wonder that food makers are adding protein to everything from yogurt to breakfast cereals to capitalize on our appetite for this macronutrient. The latest entry into the protein-packed food segment is snack foods. Witness "ProTings," a chip with 15 g of protein per ounce serving.¹

There is much misinformation about protein needs for active people, and much of it arises from popular fitness and muscle-building magazines and Web sites. In a content analysis of *Men's Health* magazine (11 issues published in 2009), Cook et al² found frequent advice to increase protein and individual amino acids for muscle building. The articles promoted magical properties of specific foods, especially protein-rich foods, on male physiology. The authors also found there was "poor" reporting of nutrition science by cherry picking results with little contextualization of the research for the reader. In conclusion, the authors state there

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is a strong "pseudo-scientific" presentation of nutrition information in this popular men's magazine to promote a lean, muscular physique.²

Information about protein in men's magazines is often pseudo-scientific.

Part of the reason for confusion is that although research on protein and athletic performance has come a long way since it was first recognized that many athletes have a higher need for protein than sedentary individuals do, we still do not know the optimal intake of protein for athletes. Phillips and colleagues³ note that although it is clear what the recommended intake of protein is to avoid deficiency, athletes want more information. They want to know the best intake of protein for muscle building; remodeling protein within bones, tendons, and ligaments; maintaining optimal function of the hundreds of metabolic pathways that use amino acids; and supporting immune function.³ Coupled with the imperfection of any study, it is no surprise that athletes are confused about protein and that magazines want to sell more copy by presenting protein research in a definitive way.

Therefore, despite the limitations to the research and with the goal of helping athletes understand the most current science on protein, this article will answer frequently asked questions from athletes about protein intake. The questions are as follows:

1. How much protein is needed after exercise to stimulate muscle protein synthesis?
2. Is protein needed during exercise?
3. Is there a best time to ingest protein, and are there specific times during the day when it is better to eat protein to support muscle anabolism?
4. What is the best source of protein for athletes?
5. Should high-protein diets be consumed when trying to lose weight?
6. When recovering from injury, can a high-protein diet prevent loss of muscle mass?
7. Are protein supplements better than food sources of protein?

These are the questions I am most often asked by athletes, parents, coaches, and trainers. From adolescent swimmers to high school athletes to elite athletes, protein is on all of

their minds. Table 1 presents the “bottom line” answer to these FAQs.

PROTEIN IN THE POSTEXERCISE PERIOD

It is well accepted that the 2 most powerful stimuli of muscle protein synthesis are exercise and nutrition.⁴ Just 1 bout of resistance exercise can increase muscle protein synthesis by 40% and by as much as 150%, but it is also followed by periods of muscle protein breakdown. Muscles need to be “fed” essential amino acids (EAAs) in the postexercise period to reduce muscle protein breakdown.⁴ For those athletes who want to build muscle, high-quality protein (ie, one that contains all of the EAAs) consumed after a bout of resistance exercise is the best practice. For endurance athletes, protein intake after exercise can help to increase mitochondrial proteins, which enhances oxygen utilization by working muscles in future exercise bouts.⁵

The amount of EAA used in studies ranges between 8 and 10 g. Phillips et al³ examined the amino acid composition of high-quality protein foods (milk, meat and eggs) and determined that 10 g of EAA translates to about 25 g of each of these proteins. Most complete proteins are about 40% EAA, hence the recommendation to consume 20 to 25 g of intact, high-quality protein after exercise. Sometimes called the “window of anabolic opportunity,” the postexercise window can last up to 24 hours, but most researchers agree that early feeding is more advantageous because this is when muscle protein synthesis is greatest.⁴ In addition, the International Olympic Committee Consensus Statement on

Sports Nutrition⁶ encourages protein consumption in the postexercise period to aid in long-term maintenance of muscle and bone and to repair tissues damaged by acute exercise. Table 2 shows common foods and beverages that provide 20 g of high-quality protein.

Some athletes believe that more is better when it comes to protein intake after exercise, but 20 to 25 g is sufficient. Intakes above 20 to 25 g of protein do not further stimulate protein synthesis but increase oxidation of amino acids with concomitant urea synthesis.³ A few other common beliefs among athletes are that the protein has to be consumed within minutes of the conclusion of exercise or it has to come from a protein shake. I have seen athletes down expensive protein shakes after a weight training session and then immediately sit down to a large meal that provided more than 20 to 25 g of protein; the protein in the meal was sufficient and they could have skipped the postworkout shake.

PROTEIN DURING EXERCISE

It is well established that consuming protein in the post-exercise period is advantageous to muscle protein synthesis, but what about consuming protein before and during exercise? Early research suggested that protein consumed before resistance exercise could increase protein balance better than when protein was ingested after exercise; however, these findings have not been replicated.^{7,8} Recently, van Loon⁹ reviewed the research on protein intake during exercise and concluded that at this time, protein feeding during exercise is not necessary if the individual is consuming sufficient

TABLE 1 Frequently Asked Questions About Protein

Question	Bottom Line Answer
How much protein is needed postexercise to stimulate muscle protein synthesis?	20–25 g of high-quality protein consumed within 2 h after exercise; this can be in the form of food, a shake, or bar consumed as a snack or at the next meal.
Is protein needed during exercise?	No, with the exception of ultraendurance exercise. Athletes may benefit from consuming protein during events that are longer than 3–5 h.
Is there a best time to ingest protein, and are there specific times during the day when it is better to eat protein to support muscle anabolism?	Distributing protein throughout the day is recommended; aim to consume about 30 g of high-quality protein (or 0.25 g/kg bw) in 5 small meals spaced evenly with an additional 40 g of protein consumed before sleep.
What is the best source of protein for athletes?	Protein that provides all of the essential amino acids is best for muscle protein synthesis. Milk protein might have the advantage over single source proteins, like soy, because milk contains both whey and casein. Whey protein is more effective than casein alone, and soy is slightly less effective than whey on muscle protein synthesis.
Should high-protein diets be consumed when trying to lose weight?	Protein intakes of 1.8–2.7 g/kg/bw or at the higher end of the Acceptable Macronutrient Distribution range of 30%–35% seem advantageous to preserve lean mass and enhance fat loss (additive effect when exercise is also performed.)
When recovering from injury, can a high-protein diet prevent loss of muscle mass?	Consume sufficient energy for healing and recovery; aim for 1.6–2.5 g/protein/kg spaced evenly throughout 4–6 feedings a day.
Are protein supplements better than food sources of protein?	There is no evidence that protein supplements are superior to food sources. Protein foods provide essential nutrients that are not present in supplements.

TABLE 2 Foods and Beverages Providing 20 g of High-Quality Protein

Food or Beverage	Amount
Fluid 1% low-fat milk (plain or flavored)	20 fl oz
Low-fat yogurt (plain)	16 oz
Low-fat Greek style yogurt (plain)	8 oz
Soy milk, plain	23 fl oz
Lean beef or pork	3 oz
Lean ground beef patty	3 oz
Poultry	3 oz
Eggs, whole	3 large
Eggs, white	6 large
Cheese, cheddar	3 oz
Cheese, low-fat string cheese	3 oz
Cottage cheese	1.5 oz
Tuna, light canned in water	3 oz
Salmon, farm-raised	3 oz

Source: USDA National Nutrient Database for Standard Reference. Release 27 (<http://ndb.nal.usda.gov/>).

protein throughout the day (more on timing and distribution of protein in the next section). van Loon makes the distinction between the muscle building aspect of protein consumption and ergogenic or performance effects of protein consumption during exercise. There is no benefit for muscle protein synthesis for most athletes and there is not a well-documented performance effect (ie, improved time to complete exercise). However, there is a sound reason for ingesting protein before and during some types of exercise. Exhaustive, intense exercise (like ultraendurance events lasting for greater than 3–5 hours) is followed by redistribution of blood flow in the recovery period.⁹ Blood is shunted to muscles with less blood going to the gut. Diminished blood flow to the gut could impair digestion and absorption of protein consumed in the postexercise period. This could negatively impact recovery so ultraendurance athletes should consume some protein before and during exercise.

A postexercise protein intake window for anabolic activity may last up to 24 hours.

TIMING AND DISTRIBUTION OF PROTEIN INTAKE

Research on protein intake in the immediate postexercise period, or the so-called window of anabolic opportunity, has been confirmed by several researchers, but what about the period of recovery beyond a few hours? Areta and colleagues¹⁰ hypothesized that consuming protein throughout the recovery period, not just limiting protein consumption to the hour or two after exercise, would be the optimal intervention for muscle protein synthesis. The researchers compared 3 patterns of protein intake during a 12-hour recovery period after a resistance exercise training session. Twenty-four healthy young men were recruited, and all had extensive resistance training for at least 2 years (23 participants were included in the final analysis as 1 subject was excluded because of a laboratory error). The subjects all received 80 g of protein (whey protein) during the 12 hours after resistance exercise but were randomly assigned to 1 of 3 groups: 10 g of protein every 1.5 hours, 20 g of protein every 3 hours, or 40 g of protein every 6 hours. Measures of muscle protein synthesis included muscle biopsy to calculate myofibrillar synthetic rate, muscle signaling responses, and mRNA. Results showed that rates of muscle protein synthesis were highest when protein was consumed with regular intake of 20 g of protein every 3 hours during the recovery phase.¹⁰ The researchers concluded that not only the source of protein (whey protein was used in this study) but also the distribution of protein throughout the recovery period maximizes muscle protein synthesis. The authors point out that their results are limited to healthy young men of average body weight and other groups should be studied to confirm the findings. They also note that whey protein was used in this study, a “fast” protein that is rapidly digested, and it is unknown if mixed protein sources from food would elicit the same response.¹⁰ Nevertheless, the pattern of distribution of protein intake regularly consumed appears superior to a typical intake of heavy protein intake at the evening meal (>30 g) with less protein (<30 g) consumed at breakfast and lunch.¹¹

In another interesting approach to providing protein for muscle anabolism, Res et al¹² looked at protein intake before bed as another way to increase muscle protein synthesis. Some athletes have been ingesting the protein casein (a “slow” protein, meaning that it is more slowly digested and absorbed, compared with “fast” proteins like whey protein) with the theory that the slow rise in amino acid concentrations during sleep would further augment daytime feeding of protein. Res and colleagues fed 16 recreational athletes who participated in resistance-type strength training. Half the subjects got a water placebo and half got water with 40 g of casein (both were flavored with nonnutritive sweetener). The results showed that the protein consumed before sleep was well digested and absorbed and that it stimulated the rate of muscle protein synthesis and improved overnight net protein balance.¹²

These studies suggest that protein distribution is an important strategy for muscle protein synthesis, and encouraging athletes to distribute protein throughout the day can elevate blood amino acid delivery to muscles. However, there is no ergogenic or performance effect to consuming protein beyond the accrual of lean mass.

PROTEIN SOURCE

We have seen that protein timing is important, but athletes want to know if there a “best” source of protein to achieve peak muscle protein synthesis. What we do know is that protein is big business. Global sales rose by 59% between the years 2006 and 2011 to sales figures of \$5.4 billion.¹³ It is no wonder that every protein source, from whey to soy, wants a piece of the market action.

Tang et al¹⁴ studied 3 different protein sources (whey, soy, and casein) in 18-year-old healthy men at rest and after resistance exercise. Six men were in each treatment and received a 100-calorie drink with either 20 g of whey protein hydrolysate, casein, or soy protein. The results showed that whey protein hydrolysate stimulated greater muscle protein synthesis than casein did. Whey and soy protein were equal in ability to stimulate muscle protein synthesis at rest, but whey was superior to soy after resistance exercise.¹⁴ The researchers suggest that the amino acid leucine is the anabolic trigger, and whey contains more leucine than other protein sources do.

Whey protein is touted as the “best” protein source for muscle building, based on studies like Tang et al. However, it is important to know that not all whey protein is the same, so athletes are encouraged to look at the whey protein source. Hydrolyzed whey protein contains 80% to 90% protein and is used primarily in infant formulas and medical nutrition therapy products. Whey protein concentrate can range from 25% to 89% protein and is often used in protein bars and beverages. Whey protein isolate is 90% to 95% protein and is also lactose-free and is frequently found in protein powders and supplements.¹⁵

Milk protein is often considered an ideal protein source for athletes because milk contains both whey (18% of cow’s milk is whey) and casein (82%).¹⁶ Milk also has the advantage of containing carbohydrate, vitamins, and minerals and contributes fluid and electrolytes lost during exercise to aid in hydration. Five hundred milliliters of fluid milk provides about 20 g of protein and is rich in the branched chain amino acids, especially leucine, which appears to be the anabolic trigger. Cockburn et al¹⁷ also have shown that consuming milk (500 mL) immediately after muscle-damaging exercise limits some of the decrements in performance that are integral to team sports performance. Fourteen healthy semiprofessional soccer players performed hamstring-damaging exercise and then were given either 500 mL of

water or fluid skim milk. They then performed a series of exercises that are used in soccer performance (jumping, sprinting, and agility), and those who consumed the milk saw less detrimental effects on performance than those who consumed the water.¹⁷

Recently, researchers have been studying protein blends to determine if different types of proteins are superior to a single protein source for muscle protein synthesis. Blends of whey and casein (rich in branched-chain amino acids) and soy protein (rich in glutamine and arginine) may enhance muscle uptake of amino acids. The differing rates of digestion of different protein sources may be more effective than single proteins by providing a steady supply of amino acids to muscles after exercise.

Reidy et al¹⁸ showed that consumption of a soy-dairy blend prolonged amino acid delivery for 2 to 3 hours after exercise. The muscle net protein balance with the blend was greater than with whey at both 60 and 120 minutes after ingestion. The study supports postexercise ingestion of protein containing adequate leucine (~1.8 g) and sufficient amino acid substrate (from both EAAs and non-EAAs) to prolong muscle protein synthesis in the 3- to 5-hour postexercise period.¹⁸

PROTEIN AND WEIGHT LOSS

Many athletes are not only trying to build lean muscle but also trying to decrease body fat. Is it possible to preserve lean mass while reducing calories to lose weight? Layman et al¹⁹ studied adult overweight women in a 16-week randomized study of diet and exercise. The women exercised by walking 5 days a week and performing resistance strength exercise 2 days a week while consuming 1 of 2 diets. The diets were isocaloric and provided about 30% of calories from fat. The diets differed in protein and carbohydrate content (1 diet provided the Recommended Dietary Allowance [RDA] of protein, 0.8 g/kg/bw, with about 3.5 g carbohydrate/kg/bw, and the other was a higher protein intake of 1.5 g/kg/bw with 1.5 g carbohydrate/kg/bw). The group consuming the higher-protein diet lost more body fat while preserving greater lean mass than did the women on the diet with the RDA for protein.¹⁹ Participants also reported greater satiety on the higher-protein diet. The protein leverage hypothesis²⁰ predicts that when the percentage of protein as part of total energy intake falls, powerful metabolic forces stimulate a drive to increase energy intake in an attempt to make up for the limited protein. Therefore, protein intakes needed to prevent deficiency (RDA intake) may not be optimal for satiety and weight management. In addition, complete proteins seem to be involved in hunger suppression through several proposed mechanisms, including recognition of EAA intake in the brain and changes in gastrointestinal food regulation hormones.²¹

The protein leverage hypothesis suggests that as protein percent of calories falls, there is a drive to increase energy intake.

In a 2006 review, Phillips²² contends that based on current research, higher protein intakes not only can help athletes preserve lean mass while dieting but can also confer the metabolic advantage of enhancing fat loss. In advising athletes who want to lose body fat while maintaining lean mass, Murphy and colleagues²³ suggest an intake of 1.8 to 2.7 g/kg/bw with a 500 calorie deficit. Continuing to undergo a resistance exercise program is also important to alter body composition.²³ Athletes would benefit from consulting with a sports dietitian who can develop a meal plan to meet the athlete's body composition goals while at the same time ensuring adequate intake of other macronutrients.

PROTEIN AND RECOVERY FROM INJURY

Injuries are, unfortunately, a part of every athlete's life. Athletes often ask if consuming more protein while injured will help speed recovery and prevent the loss of muscle mass that comes from inactivity and/or immobilization. There is very little information on optimal nutrition strategies for athletes recovering from injury. However, it is known that when a limb is immobilized and/or there is little anabolic stimulus to muscle, a net negative muscle protein balance occurs.²⁴ Although it may be tempting to increase protein intake, without the anabolic stimulus of resistance exercise, the impact of added protein is most likely limited. Adequate protein is important, but possibly more important is adequate energy intake. Athletes tend to drastically cut calories when injured because they know they are not training and competing as they were before the injury. Cutting calories too drastically can be counterproductive. The healing process requires energy, and the energy cost of movement (eg, using crutches) is higher than many athletes believe.²⁴ There is a delicate balance between providing enough energy for healing while at the same time minimizing body fat accumulation. Therefore, although consumption of high-quality protein is important, sufficient energy and micronutrient consumption is even more important to an injured athlete. Wall et al²⁵ suggest protein intakes of 1.6 to 2.5 g/kg during injury and recovery with 4 to 6 meals per day, with protein evenly spaced throughout the day. However, the authors of the review point out that there are no long-term studies assessing the effect of a high-protein intake on muscle maintenance during injury.

PROTEIN SUPPLEMENTS

Many athletes believe that protein supplements are superior to food sources. Fueled by the promises of quick muscle growth and superior body compositions, protein supplements are sold everywhere, from mass market distributors like Walmart to supplement shops like General Nutrition Center to Internet Web sites. Athletes may not realize that protein supplements may be manufactured with poor quality control, leading to contamination with heavy metals or the inclusion of anabolic ingredients that are not listed on the label.²⁶ Supplements can also contain banned substances that could lead to disqualification or worse if an athlete is drug tested for his/her sport. Maughan²⁶ sums up the risks of ingesting dietary supplements, including protein supplements, as follows:

- Absence of active ingredients
- Presence of harmful substances
- Presence of toxic agents
- Presence of potentially dangerous prescription-only pharmaceuticals

Athletes who want to compete at any level of sport (high school, college, elite, semiprofessional, or professional) may not have the knowledge to assess the risk-benefit of using dietary supplements. Couple that with unscrupulous marketing and sales tactics, and it can be hard for athletes to say no to supplements. Some retailers offer sales associates a commission to sell certain products and have been known to steer athletes to purchase supplements with no known efficacy to increase their commission.²⁷

Protein powders and shakes may be perceived as more convenient and portable than food by athletes. It is easy to throw a protein-rich energy bar in a gym bag and less convenient to make and pack a turkey sandwich in an insulated bag to keep it at a same temperature. A scoop of protein powder is an easy-to-measure dose that can provide 10 to 20 g of protein, whereas to get 20 g of protein from egg whites, 6 large eggs are needed. However, it is important to remind athletes that protein-rich foods are more than just amino acids. Dairy foods also provide carbohydrate and nutrients that might be in short supply in an athlete's diet: calcium, potassium, and vitamin D. Whole eggs provide carotenoids lutein and zeaxanthin, as well as choline. Soy foods can be a good source of dietary fiber and provide a complete protein source for vegetarian and vegan athletes.²⁸

Lastly, protein supplements are expensive. Athletes on limited budgets would be better off spending money on nourishing foods to build muscle and fuel sport instead of supplements.

CONCLUSIONS

Protein is an important nutrient for athletes, and research on protein needs, source, timing, and distribution has

rapidly expanded our understanding of its role in body composition and sports performance. However, athletes cannot live on protein alone. High-protein diets may be beneficial to build and maintain lean mass, but high protein does not mean excessive protein.²⁹ Protein needs depend on many factors: stage of training, duration and intensity of exercise, sport played, energy expenditure, and age. When protein intake increases, carbohydrate intake may decrease, leading to fatigue and poor training.²⁹ Higher protein intakes also increase the need for higher water intake to eliminate excess nitrogen as urea through the kidneys. Just as athletes seek sport-specific help for training and conditioning by consulting with coaches, athletes would benefit from seeking nutrition planning from a registered dietitian nutritionist who has experience working with athletes. The research on timing and distribution of protein to enhance muscle mass speaks to a “food first” approach. A sports dietitian can develop meal plans to meet all of an athlete’s nutritional needs while helping the athlete achieve desired lean mass and performance goals.

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