THE IMPORTANCE OF PROTEIN FOR ATHLETES

SARAH ROMOTSKY, RD, AND LESLIE BONCI, MPH, CSSD, RDN

Strength and conditioing professionals help their athletes to optimize strength goals using two key components: resistance exercise and nutritional recommendations. Protein consumtion can play an important role in maximizing athletic performance. According to the International Food Information Council Foundation's 2014 Food and Health Survey, the majority of Americans agree that it is important to consume enough protein in their diet and that protein can help build muscle (20). Over half of Americans also correctly believe that protein can enhance recovery from exercise and that diets high in protein can help with weight loss (20). Although these statistics suggest that many Americans are aware of the benefits of protein, confusion and misperceptions on this topic may still exist. The top two reasons cited as to why Americans are not consuming more protein is because they believe they are already getting enough protein and because they think high-protein foods are more expensive (20). Americans trying to build muscle and optimize strength may not be consuming enough protein or consuming it at the right times. The goal of this article is to help strength and conditioning professionals properly educate clients on how protein can go a long way in assisting them in achieving their health and fitness goals.

PROTEIN BASICS

There are 20 amino acids, which are the building blocks of protein. Ten of these amino acids are non-essential (i.e., the body can produce them) and the other 10 are essential (i.e., only obtained through food), and without them, the body cannot synthesize new protein (21). Of the 10 essentials amino acids, valine, leucine, and isoleucine are the branched-chain amino acids, which stimulate muscle protein synthesis and help to prevent muscle breakdown (2,9). The following is a list of the 10 essential and 10 non-essential amino acids (21):

Essential Amino Acids	Non-Essential Amino Acids
Isoleucine*	Asparagine
Leucine*	Cysteine
Lysine	Alanine
Threonine	Aspartate
Tryptophan	Glutamate
Methionine	Glutamine
Histidine	Proline
Valine*	Glycine
Phenylalanine	Tyrosine
Arginine	Serine

**Branched-chain amino acids*

Protein is an important macronutrient because it plays several roles in the body. Many are already familiar with protein's function in weight management, lean body mass, and muscle repair; however, protein is also critical for supporting a healthy immune system, maintaining glucose homeostasis, and optimizing bone mineral density (10).

Protein amounts in the body are constantly changing, which is why dietary protein consumption is so important (1,5). The amount of available free amino acids in the body can come from amino acids generated from protein digestion in food, as well as from skeletal muscle breakdown. The amino acid pool ensures a continuous availability of amino acids for protein synthesis and other functions. Consumption of adequate amounts of essential amino acids is the key step in ensuring adequate amounts of amino acids are in the free amino acid pool. If essential amino acid consumption is insufficient, protein synthesis cannot occur.

HOW MUCH PROTEIN?

The Recommended Dietary Allowance (RDA) is 0.66 g of protein per kg of bodyweight per day for adults over 18 years of age (20,22). This intake has been defined by the Institute of Medicine following their review of the available literature as the level sufficient to meet the nutrient requirement of 97 – 98% of all healthy individuals (3). Data from the National Health and Nutrition Examination Survey (NHANES) has shown that most Americans are meeting the RDA requirement for protein (20,22). However, an important distinction is that the RDA is only meant to prevent deficiency, but does not necessarily promote optimal health. The current RDA recommendation may not be optimal for older adults and athletes, two subpopulations that may require more protein for optimal health.

The RDA is only one context through which to examine protein requirements. The Acceptable Macronutrient Distribution Range (AMDR) may be a better choice. The AMDR defines protein requirements as a range rather than an absolute number. The AMDR for protein for anyone over 18 years of age is 10 – 35% of calories consumed (3). For someone consuming 2,000 calories per day, this would be about 50 – 175 g of protein per day (22). According to NHANES data, Americans consume only about 16% of their calories from protein, so the average person's proportion of calories from protein is actually rather low (20,22). Furthermore, studies on satiety (the feeling of fullness between meals) have demonstrated that in order to achieve increased satiety, protein should comprise about 25% of a person's caloric intake (4).

PROTEIN REQUIREMENTS BY SPORT

Recommended protein intake is not "one-size-fits-all" and is based on sport, age, and bodyweight. Table 1 provides basic guidelines based on requirements for a general 150-lb athlete (22).

PROTEIN SOURCES AND QUALITY

There are a variety of animal-based and plant-based protein sources available to accommodate all diets, preferences, tastes, and budgets. Tables 2 and 3 provide approximate amounts of protein from various sources and the caloric amounts (11,12).

Many athletes inquire about what types of protein they should consume. This is a good question because the quality of the protein source is important for optimal effectiveness. Protein quality in foods is determined by its specific amino acid composition and digestibility. Both animal-based and plant-based protein sources provide essential and non-essential amino acids to meet the body's protein needs. Proteins are classified as complete (i.e., containing all of the essential amino acids) or incomplete (i.e., missing one or more of the essential amino acids) (2,9). Incomplete proteins are sometimes referred to as the limiting amino acids (21).

Complete	**Incomplete**
Meat	Legumes
Poultry	Grains
Fish/shellfish	Nuts/nut berries
Eggs	Seeds/seed butters
Dairy foods	Vegetables
Soy foods	

USING PROTEIN TO BUILD MUSCLE

Adequate protein intake or resistance training alone can increase muscle protein synthesis, but the combination of both optimizes results (13). To maintain or increase muscle, the body must be able to synthesize protein. Consumption of dietary protein increases the blood amino acid levels which leads to anabolism, or muscle protein synthesis (10,13,17,18,19).

Leucine is one of the essential branched-chain amino acids that signals muscle protein synthesis. It acts as a dietary trigger to support an anabolic response in muscle tissue, while also contributing to skeletal muscle replenishment during periods of food restriction. Above and beyond basic protein requirements, if the goal is to optimize muscle protein synthesis, each meal needs to contain around 2.5 g of leucine (13,21). Leucine is prevalent in most proteins, but can be in limited supply in plant proteins. This means athletes may need to eat a higher quantity of plant proteins in order to obtain adequate amounts of leucine. Table 4 provides the approximate amounts of leucine found in certain food items.

Consuming 30 g of high-quality protein at meals will typical provide an adequate amount of the branched-chain amino acids, including the necessary 2.5 g of leucine. For example, a lunch consisting of a tuna sandwich with 3 oz of tuna, lettuce, tomato, two slices of whole-grain bread, and an 8-oz glass of skim milk will meet the requirements for muscle protein synthesis (14). It is important to remember that both plant and animal sources can contribute to the total protein content of a meal and that the 30 g recommendation is a general guideline that will vary depending on an athlete's activity level, age, and specific needs.

Combining different types of protein may maximize muscle growth and allow a longer time for muscle repair (13). Whey and soy are fast acting proteins (quickly digested) while casein is a slow protein (slowly digested) (18). A mix of fast and slow proteins may help promote muscle protein synthesis and prolong protein net balance following resistance exercise (13,14,19). Blending protein can be done by using different protein powders such as whey, soy, casein, or through foods that comprise a variety of sources such as a stir-fry that contains beef, peanuts, and asparagus.

PROTEIN AND RESISTANCE TRAINING: THE PERFECT COMBO

In a fasting state, while the body is at rest, protein balance in the body is negative (2). When eating, there is a shift to a positive state, which results in protein gain. Exercising in a fasting state can result in a negative protein balance. It is not until exercise is combined with eating that the body can shift to a positive protein balance (2).

When resistance training is added, the fasting state losses are slightly reduced while the feeding state gains are slightly enhanced. If this pattern is repeated over time, lean body mass can be increased (10).

PROTEIN DISTRIBUTION AND TIMING

In order to optimize muscle protein synthesis and keep the body in a positive protein balance, it is recommended to distribute protein evenly throughout the day. Evenly distributing protein over the day allows for anabolism (1,19). If someone is aiming to consume 120 g of protein per day, the ideal distribution would be to ingest 30 g of protein at each meal and divide the remaining 30 g among snacking occasions (9).

To help maximize muscle protein synthesis, it can be helpful to know how to "bookend" workouts with protein consumption before and after. A guideline for athletes to follow would be 20 g of protein plus 35 g of carbohydrate 30 – 60 min before lifting (e.g., 8 oz Greek yogurt and a small banana) and 20 g of protein plus 35 g of carbohydrate within 15 – 30 min after lifting (e.g., three slices of turkey or ham, one slice of cheese, one English muffin, and one apple). Consuming protein with carbohydrates as described earlier will provide fuel to the working muscles before exercise, and also indirectly stimulates the release of growth hormones when consumed post lifting (2,6,16).

HIGH-PROTEIN DIETS AND WEIGHT LOSS

Many strength and conditioning professionals have athletes who are working towards weight loss goals in addition to fitness goals. Numerous studies have shown dietary protein to be a powerful ally in reaching weight loss goals. In one research study involving a 16-week diet and exercise program, subjects in the protein-only and protein-plus-exercise groups lost more total weight and fat mass and tended to lose less lean mass than the carbohydrate-only and carbohydrate-plus-exercise groups (7). The researchers concluded that as part of a reduced-calorie diet, diets higher in protein may help to preserve lean body mass during weight loss, with the effect magnified when an exercise component is added to the weight loss program.

Another study compared a moderate-protein diet to a conventional high-carbohydrate diet to understand the effects of protein on body fat. At four months, subjects in the protein group had lost 22% more fat mass than the carbohydrate group and tended to lose less lean mass (8). At 12 months, the protein group had greater improvements in body composition and those who consumed a diet of 30% protein lost more body fat after one year than those who consumed a diet of 15% protein (8).

In addition to muscle mass preservation and accelerated body fat loss, protein may also help with satiety. One short-term study indicated that protein intake may exert a more powerful effect on satiety than either carbohydrate or fat consumption (4).

TRANSLATING THE SCIENCE TO THE TABLE

Protein is part of the package for health, athletic, and fitness goals. Although the quantity of protein needed to optimize goals varies depending upon an athlete's age and activity level, the need for high-quality protein sources remains constant. There are a variety of protein sources available in food, which is the most common way to meet protein needs. However, supplements can be considered if it is necessary to augment an inadequate protein intake. As strength and conditioning professionals, it is important to help athletes understand the benefits of protein consumption and when to incorporate it into their diet.

For some, consuming 30 g of protein at each meal can be challenging, which is why snacks and boosters to meals can be helpful in meeting requirements. For these reasons, here are a few suggested high-protein foods that can be used for snacks between meals or as "add-ons" to meals to increase the total protein content.

10-g Protein Snacks and Boosters

- ½ cup whey protein powder
- ½ cup Greek yogurt or ½ cup yogurt with 1 tbsp soy protein powder
- 2 eggs or ⅓ cup egg substitute
- 2 oz cheese
- ½ commercial protein shake
- 10 oz low-fat milk (white or chocolate) or soy milk
- ½ sandwich with 1 ½ oz lean meat
- ¼ cup tuna salad
- 2 tbsp peanut butter
- 2 strips beef/turkey jerky
- Yogurt smoothies
- Protein bar

Strength and conditioning professionals are already in a position to have a huge impact on an athlete's health and wellness goals. By highlighting the proven benefits of protein and by providing them with applicable strategies for incorporating protein into their diets, strength and conditioning professionals can help their athletes maximize performance and maintain a healthy lifestyle.

REFERENCES

1. Atherton, PJ, Etheridge, T, Watt, PW, Wilkinson, D, Selby, A, Rankin, D, Smith, K, and Rennie, MJ. Muscle full effect after oral protein: Time-dependent concordance and discordance between human muscle protein synthesis and mTORC1 signaling. *American Journal of Clinical Nutrition* 92(5): 1080-1088, 2010.

2. Beelen, M, Burke, LM, Gibala, MJ, and van Loon, LJC. Nutritional strategies to promote post exercise recovery. *International Journal of Sport Nutrition and Exercise Metabolism* 20(6): 515-532, 2010.

3. Dietary Reference Intakes: Macronutrients. Acceptable Macronutrient Distribution Range. Institute of Medicine. Retrieved 2014 from http://www.iom.edu/Global/News%20Announcements/~/media/C5CD2DD7840544979A549EC47E56A02B.ashx.

4. Halton, TL, and Hu, FB. The effects of high protein diets on thermogenesis, satiety and weight loss: A critical review. *Journal of American College of Nutrition* 23(5): 373-385, 2004.

5. Holm, L, Olesen, JL, Matsumoto, K, Doi, T, Mizuno, M, Alsted, TJ, Mackey, A, Schwarz, P, and Kjaer, M. Protein containing nutrient supplementation following strength training enhances effect on muscle mass, strength and bone formation in post-menopausal women. *Journal of Applied Physiology* 105(1): 274-281, 2008.

6. Howarth, KR, Moreau, NA, Phillips, SM, and Gibala, MJ. Co-ingestion of protein with carbohydrate during recovery from endurance exercise stimulates skeletal muscle protein synthesis in humans. *Journal of Applied Physiology* 106(4): 1394-1402, 2009.

7. Layman, DL, Evans, EM, Baum, JL, Seyler, J, Erickson, DJ, and Boileau, RA. Dietary protein and exercise have additive effects on body composition during weight loss in adult women. *Journal of Nutrition* 135(8): 1903-1910, 2005.

8. Layman, DL, Evans, EM, Erickson, DJ, Seyler, J, Weber, J, Bagshaw, D, Griel, A, Psota, T, and Kris-Etherton, P. A moderate-protein diet produces sustained weight lost and long-term changes in body composition and blood lipids in obese adults. *Journal of Nutrition* 139(3): 514-521, 2009.

9. Mamerow, MM, Mettler, JA, English, KL, Casperson, SL, Arentson-Lantz, E, Sheffield-Moore, M, Layman, DL, and Paddon-Jones, P. Dietary protein distribution positively influences 24-h muscle protein synthesis in healthy adults. *Journal of Nutrition* 144(6): 876-880, 2014.

10. Phillips, SM, and van Loon, LJC. Dietary protein for athletes: From requirements to optimum adaptation. *Journal of Sports Science* 29 (suppl 1): S29-38, 2011.

11. Phillips, SM, Moore, DR, and Tang, JE. A critical examination of dietary protein requirements, benefits and excesses in athletes. *International Journal of Sport Nutrition and Exercise Metabolism* 17(suppl): S58-76, 2007.

12. Phillips, SM. Protein requirements and supplementation in strength sports. *Journal of Nutrition* 20(7): 689-695, 2004.

13. Reidy, PT, Walker, DK, Dickinson, JM, Gundermann, DM, Drummond, MJ, Timmerman, KL, et al. Protein blend ingestion following resistance exercise promotes human muscle protein synthesis. *Journal of Nutrition* 143(4): 410-416, 2013.

14. Reidy, PT, Walker, DK, Dickinson, JM, Gundermann, DM, Drummond, MJ, Timmerman KL, et al. Soy-dairy protein blend and whey protein ingestion after resistance exercise increases amino acid transport and transporter expression in human skeletal muscle. *Journal of Applied Physiology* 116(11): 1353-1364, 2014.

15. Symons, TB, Sheffield-Moore, M, Wolfe, RR, and Paddon-Jones, D. A moderate serving of high quality protein maximally stimulates skeletal muscle protein synthesis in young and elderly. *Journal of the American Dietetic Association* 109(9): 1582-1586, 2009.

16. Tang, JE, Manolakos, JT, Kujbida, GW, Lysecki, PJ, Moore, DR, and Phillips, SM. Minimal whey protein with carbohydrate stimulates muscle protein synthesis following resistance exercise in trained young men. *Applied Physiology, Nutrition, and Metabolism* 32(6): 1132-1138, 2007.

17. Tang, JE, Moore, DR, Kujbida, GW, Tarnopolsky, MA, and Phillips, SM. Ingestion of whey hydrolysate, casein, or soy protein isolate: Effects on mixed muscle protein synthesis at rest and following resistance exercise in young men. *Journal of Applied Physiology* 107(3): 987-992, 2009.

18. Tipton, KD, Elliott, TA, Cree, MG, Sanford, AP, and Wolfe, RR. Ingestion of casein and whey proteins result in muscle anabolism after resistance exercise. *Medicine and Science in Sports and Exercise* 36(12): 2073-2081, 2004.

19. Tipton, KD, Rasmussen, BB, Miller, SL, Wolf, SE, Owens-Stovall, SK, Petrini, BE, and Wolfe, RR. Timing of amino acid-carbohydrate ingestion alters anabolic response of muscle to resistance exercise. *American Journal of Physiology, Endocrinology, and Metabolism* 281(2): E197-206, 2001.

20. United States Department of Agriculture. Dietary reference intakes (DRIs): Estimated average requirements. Retrieved 2014 from http://www.nal.usda.gov/fnic/DRI/DRI_Tables/recommended_intakes_individuals.pdf.

21. United States National Agricultural Library. Protein and Amino Acids. Retrieved 2014 from http://www.nal.usda.gov/fnic/DRI/DRI_Energy/589-768.pdf.

22. University of Wisconsin-Milwaukee College of Health Sciences – Department of Kinesiology. The Power of Protein. Presented by Susan Kundrat. Retrieved 2014 from http://eatrightmn.org/docs/Kundrat%20-%20POWER%20OF%20PROTEIN%20KUNDRAT%20FINAL%204_14.pdf.

ABOUT THE AUTHOR

Sarah Romotsky is the Associate Director of Health and Wellness at the International Food Information Council. Her responsibilities include the development and implementation of strategic communication initiatives, creation of external educational materials, leading consumer research projects, and speaking at professional conferences. Romotsky received a Bachelor of Arts degree in Mass Communications from the University of California-Berkeley and later completed the Dietetic Program at San Francisco State University. Before obtaining her Registered Dietitian (RD) credentials, she managed several national advertising campaigns at leading agencies and worked in marketing for a start-up company developing functional food products. Romotsky's experience as a dietitian includes communications, clinical nutrition, nutrition counseling, and corporate wellness.

Leslie Bonci is the Director of Sports Medicine Nutrition for the Department of Orthopaedic Surgery and the Center for Sports Medicine at the University of Pittsburgh Medical Center (UPMC). She serves as the sports dietitian for the University of Pittsburgh's Department of Athletics, and is a nutrition consultant for the Pittsburgh Steelers National Football League (NFL) team, Pittsburgh Penguins National Hockey League (NHL) team, Pittsburgh Pirates Major League Baseball (MLB) team, Toronto Blue Jays MLB team, Washington Nationals MLB team, the Kansas City Chiefs NFL team, and Pittsburgh Ballet Theatre. Bonci also works with Olympic, high school, and master's athletes. She was a national media spokesperson for the American Dietetic Association and currently serves on the Editorial Advisory Board for "Fitness Magazine." Additionally, Bonci has her own weekly segment, "The Winning Plate," on Pittsburgh KDKA-TV's "Pittsburgh Today Live."

TABLE 1. BASIC PROTEIN GUIDELINES FOR A 150-LB ATHLETE (22)

TYPE OF ATHLETE	PROTEIN (g PER LB OF BODYWEIGHT)	DAILY PROTEIN REQUIREMENTS FOR A 150-LB ATHLETE
Recreational	0.5 – 0.7	75 – 105 g
Endurance	0.5 – 0.8	75 – 120 g
Strength Training	0.5 – 0.8	75 – 120 g
Teenage Athlete	0.7 – 0.9	105 – 135 g
Athlete Building Mass	0.6 – 0.9	90 – 135 g
Athlete Restricting Calories	0.9 – 1.0	135 – 150 g
Maximum Usable Amount	0.9 – 1.0	135 – 150 g

TABLE 2. APPROXIMATE PROTEIN QUANTITIES FROM ANIMAL SOURCES

FOOD	PROTEIN (IN GRAMS)	CALORIES
Meat, poultry, or fish (cell phone sized portion)	21	90 – 165
Canned tuna (3 oz)	21	89 – 145
Hamburger (3 oz)	21	190 – 230
Greek yogurt (4 – 6 oz)	11 – 17	60 – 90
Regular yogurt (4 – 6 oz)	5 – 8	80 – 110
Large eggs (2)	14	144
Cottage cheese (½ cup)	14	81 – 108
Cheese (1 slice)	7	70 – 110
Deli meat (3 slices/3 oz)	9 – 18	88 – 264

TABLE 3. APPROXIMATE PROTEIN QUANTITIES FROM PLANT SOURCES

FOOD	PROTEIN (IN GRAMS)	CALORIES
Quinoa (1 cup)	8	222
Whole wheat toast (2 slices)	6	200
Broccoli (1 cup)	3.7	55
Brown rice (1 cup)	5	216
Black beans (½ cup)	7	105
Lentils (½ cup)	12.5	161
Tofu (6 oz)	16.8	155
Hummus (¼ cup)	4.4	93
Edamame (½ cup)	16.6	188
Nuts (1 oz)	4.3 – 6.7	164
Veggie burger	10	110
Soy sausage	15	120
Peanut butter (2 tbsp)	8	188

TABLE 4. APPROXIMATE AMOUNTS OF LEUCINE IN FOODS

FOOD	LEUCINE (IN GRAMS)
Greek yogurt (4 oz)	2.5
Beef (3 oz)	2.15
Chicken (3 oz)	2.0
Tuna (3 oz)	1.75
Salami (3 oz)	1.45
Soy protein powder (20 g)	1.4
Milk (8 oz)	0.85
Peanuts (⅓ cup)	0.75
Lentils (½ cup)	0.65
Large egg (1)	0.6
Almonds (⅓ cup)	0.4
Asparagus (½ cup)	0.1