

How Much Protein?

By William Misner, Ph.D.



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The more prolonged or intense the exercise, the more protein the body cannibalizes for energy from the working muscles.

Researchers measured the protein-calorie cost of exercise to be between 6% and 15% of the total energy expense each hour. Proteins metabolized from lean muscle stores are rate-limited (regulated) by the release of specific enzymes. For example, Leucine, a branch chain amino acid (BCAA), oxidation rate is controlled by the enzyme, *Branched-Chain Oxo-Acid-Dehydrogenase* (BCOAD). This enzyme is relatively low at rest (4-7%), but during exercise, dephosphorylation releases it to as high as +25%. After exercise, both BCOAD and Leucine oxidation are attenuated, though total BCOAD is up-regulated.[2] Some research utilize higher amino acid catabolism, (+15%) during endurance exercise.[3] It is conceded that as pace increases from slow aerobic to faster anaerobic, the % of amino acids burned also increase. However, for this article, the slower pace conservative 6% rate will be applied.[4]

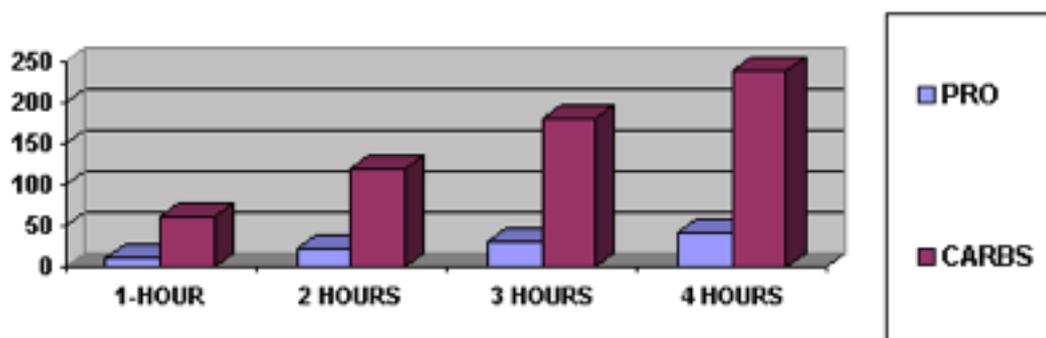
If the diet is calorie sufficient, low exercise activity has little impact on protein requirement; a 1.0 gram/protein per kg/day is sufficient. However, most endurance athletes require more dietary protein intake for 3 reasons:

1. Insufficient carbohydrate calories to meet energy expense
2. Insufficient protein calories to meet energy expense
3. Exercise training expenditure increases 10-fold above resting state

Studies confirm that both endurance and strength training increase skeletal muscle protein synthesis (breakdown). Researchers using nitrogen balance measuring technique confirm protein requirements for endurance exercise is increased to between 1.2-1.4 g/kg bodyweight per day. The timing of and nutritional content of the post-exercise meal is surprisingly overlooked. The post-exercise meal can be manipulated to reproduce synergistic protein accretion effects *after* exercise.[5] However, this effect may not occur if the post-exercise protein content is absent, poorly timed, especially if endurance duration and intensity create a severe energy deficit.

THE MATH: Each hour exercise metabolizes approximately 700 calories, 42 of which are cannibalized from lean muscle amino acid stores (-10.6 grams protein/hour), which need to be replaced *immediately after* the workout (See figure 1).

FIGURE 1 - CARBOHYDRATE & PROTEIN PER-GRAM COSTS DURING AEROBIC ENDURANCE EXERCISE (4 calories = 1 gram)



Exercise creating an energy deficit causes muscles to release large quantities of non-essential amino acids, glutamine and alanine. This protein-burning process is called "Gluconeogenesis." It occurs when the liver senses falling blood glucose from inadequate carbohydrates being supplied from muscle and liver glycogen stores. The liver "recruits" upward to 16% of the body's required calories for exercise. One study found that *Leucine oxidation* during an easy 55% VO2 Max effort increased by +240%. Consuming small amounts of branched chain amino acids (BCAA) prevents lean muscle mass loss. BCAAs comprise over 1/3rd of all muscle amino acid stores. Hammer Gel, Sustained Energy, and Perpetuem advance recovery and prevent severe lean muscle mass loss by the BCAA or complete protein ingredients. For complete protein replacement immediately following exercise, Hammer Whey and Hammer Soy protein isolates are recommended.

BCAA plus complete Protein replacement for endurance exercise is required for:

1. Increased uptake of BCAA from the circulation
2. Required BCAA for muscle protein synthesis
3. Replacing breakdown of other muscle amino acids

PROTEIN REQUIRED (grams per day)

Weight (lbs)	Leucine	Valine	Isoleucine	Total Daily Protein
110	3.0	2.5	1.0	70
132	3.6	3.0	1.2	84
154	4.2	3.5	1.4	98
176	4.8	4.0	1.6	112
198	5.4	4.5	1.8	126
220	6.0	5.0	2.0	140

MORE EXERCISE = MORE PROTEIN

Research confirms that rate of recovery and muscle synthesis rate are dramatically increased if amino acids and carbohydrates is consumed together immediately after the exercise training. Intense training may increase dietary protein requirements to as high as 1.7 grams protein per kilogram bodyweight per day. Researchers was examined a group of Ultrarunners to see how food absorbed effected blood chemistry during an extreme endurance event running 50 km (31 miles/day) for 20 consecutive days. Changes in the muscle's fat-free compartment and its relation to the corresponding biochemical and nutritional parameters of 42 male and 13 female 1000k ultra runners initially increased, but decreased in the middle phase, and stabilized for the rest of the run. Significant changes in the fat-free weight occurred from the 11th day on; lean body mass decreased until the middle of the distance runned; lean body mass rebound increasing until the end. All the muscle-circumferences were reduced with the exception of the thigh, which grew, paralleling the CK/CKMB-concentrations, a phenomenon due to the high mechanical stress on the lower extremities. The biochemical parameters exhibited a strain-related reaction of adaptation within the initial 6 days, the hormones and protein-concentrations increasing in the beginning and falling from the third day on, uric acid and CK/CKMB-activity

decreasing from the 6th day on. A consecutive parallel reduction of uric acid, urea, and muscle measurements might be seen as a special endurance-related clearance-mechanism of potential toxicants. The negative relationship between the changes of muscle measurements and the cumulative protein intake and the catabolic constellation of the clinical-chemical values might suggest that the absolute protein intake of 1.7 g/kg body mass should be increased in order to diminish the loss of musculature during an ultra-long distance run.[6]

More exercise requires more protein therefore:

- 1.2 grams/kg/day is required for 1-1.5 hours exercise
- 1.4 grams/kg/day is required for 2-4 hours
- 1.7 grams/kg/day protein is required to replace amino acids cannibalized during extreme exercise lasting 5 hours or longer

PROTEIN TIMING

Timing of protein intake is *important during and immediately after exercise*. Biolo et al. reported that protein stimulates muscle protein synthesis more *after* exercise than before. IV-amino acid infusions (alanine, phenylalanine, leucine, and lysine) were given subjects during sedentary and post-exercise states. The muscle protein synthesis rate surprisingly increased +291% arterial amino acids *after* exercise compared to +141% increases from protein infusions given before exercise. Increases of +64% leg blood flow rate occurred *after* exercise above at rest levels. Amino acid transport increased 30-100% greater *after* exercise than before exercise. Dietary protein stimulates muscle protein synthesis more *after* exercise than before or during exercise. Partly this effect is due to enhanced blood flow. Protein consumed *immediately after* exercise reproduces a greater muscle growth effect than when consumed at any other time.[7]

ANABOLIC GROWTH FROM RESISTANCE TRAINING

Resistance exercise produces a net protein synthesis that may reverse age-associated muscle mass loss. As noted, muscle protein synthesis is synergistically influenced by post-exercise supplementation, but the importance of protein timing is needs to be resolved. Research examined the importance of *immediate* (p0) oral protein or *delayed* (p2) intake of an oral protein supplement upon muscle hypertrophy and strength during a period of resistance training in elderly males. Thirteen men (74 years; body mass index (BMI) of 24-26 kgm (-2) completed a 12-week resistance training program (3 times per week)

receiving oral protein in liquid form of 10 g protein (42%), 7 g carbohydrate (29%), 3 g fat (28%) immediately following resistance training immediately after (p0) or 2-hours after (p2) each training session. Muscle hypertrophy was evaluated by magnetic resonance imaging (MRI) and from muscle biopsies. Muscle strength was determined using dynamic and isokinetic strength measurements. Body composition was determined from dual-energy X-ray absorptiometry (DEXA) and food records were obtained over 4 days. The plasma insulin response to protein supplementation was also determined. In response to training, the cross-sectional area of the muscle quadriceps femoris increased from 54.6 to 58.3 cm² and mean fibre area increased from 4047 to 5019 microm² in the post-exercise supplementation p0 group, whereas no significant increase was observed in p2. Post-exercise supplementation p0 dynamic and isokinetic strength increased by 46%, but p2 dynamic and isokinetic strength increased by only 15% and isokinetic strength by only 36%. No differences in glucose or insulin response were observed between protein intake at 0 and 2 hours post-exercise. This demonstrates that early intake of an oral protein supplement following resistance training is very important for skeletal muscles growth even in elderly males - muscle growth response *after* resistance training.[8]

SOLUTIONS TO EXERCISE-INDUCED PROTEIN DEFICIENCY

Several sport scientists advocate a 4:1 ratio of protein to carbohydrate for muscle synthesis following exercise. Though the 4:1 ratio is popular and rational, a 3:1, 2:1, or 1:1 ratios need to be evaluated. The research report (above) in elderly subjects consumed only a 4:3 carbohydrate:protein during their post-exercise recovery intervention. Some researchers demonstrate that a higher dietary protein intake (up to 1.6 g protein kg⁻¹ d⁻¹) in order to reproduce a hypertrophic response to resistance exercise. It has been demonstrated that very old men and women who consumed a protein supplement achieved a greater strength and muscle mass gain than those consuming a no-protein placebo. The important adage is to include adequate protein and carbohydrates immediately following exercise.[9] [10] This may mean more protein and more carbohydrates should accompany exercise intensity increase.

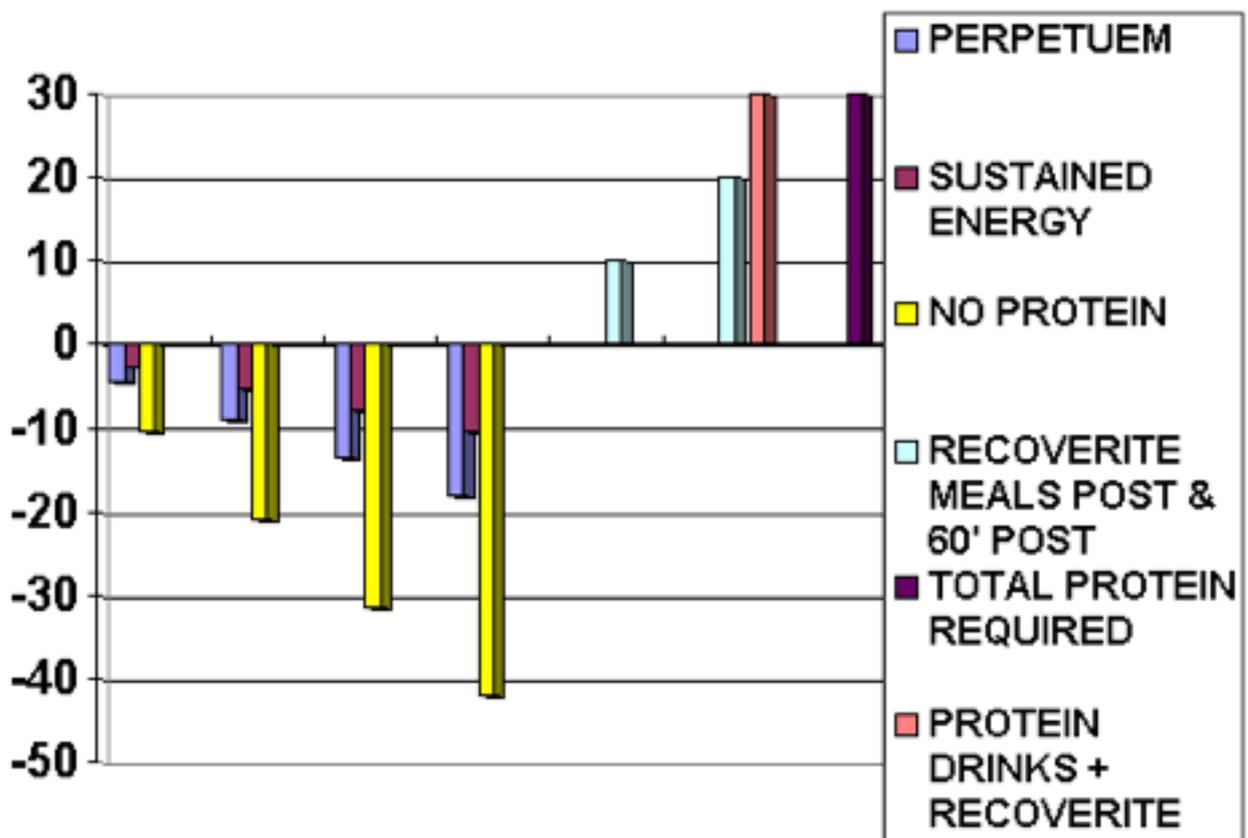
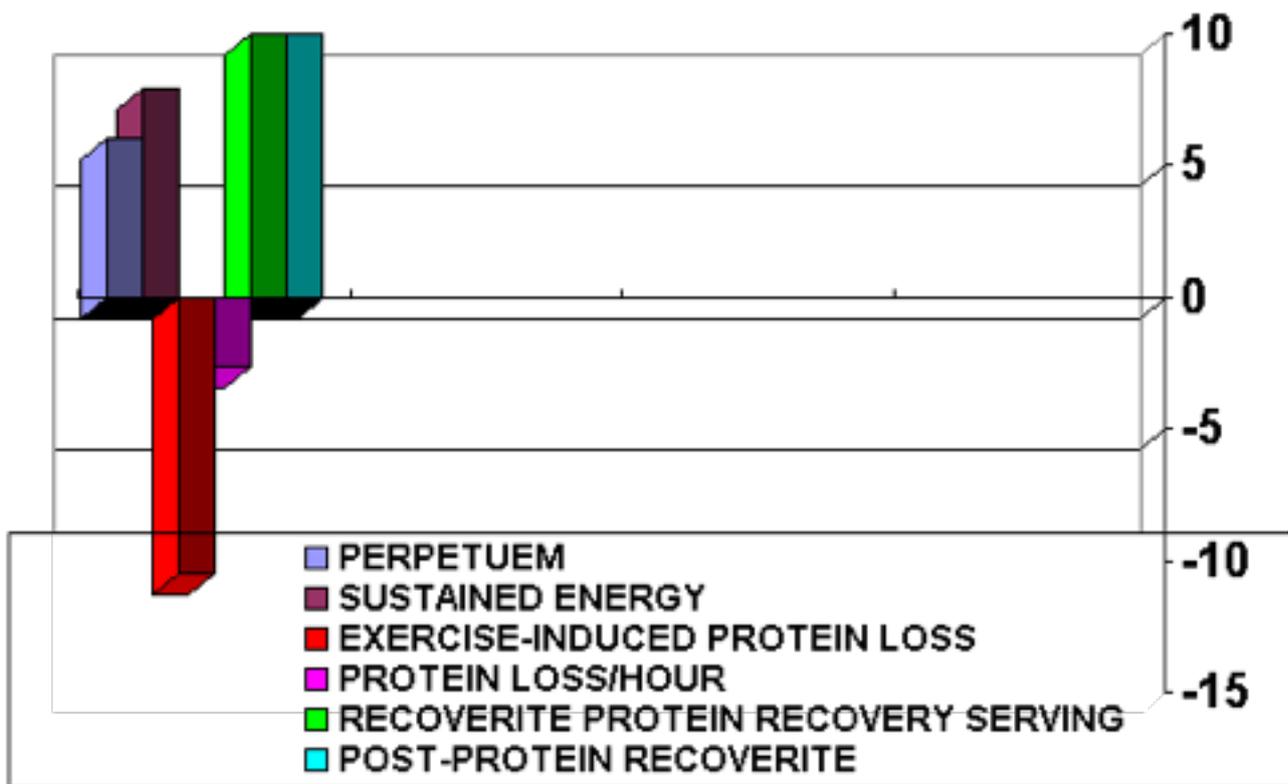
Carbohydrate (260 calories per/hour +/- 20 k/cal) consumed with proteins during workouts reduces the exercise-induced toll on lean muscle mass wasting with performance implications. After 70-90 minutes of exercise, glycogen stores dip low enough to commence recruiting amino acids from lean muscle stores into the energy cycle at a greater rate. Replacement of cannibalized

protein needs to begin during exercise and restored within 30 minutes (ideal) to 120 minutes after exercise in the presence of a cell carrier enzyme, glycogen synthase, which is released in proportion to muscle glycogen depletion. This enzyme companions the blood glucose insulin increase from carbohydrate digestion. Together insulin and glycogen synthase potently "drive" protein deep into lean muscle mass cells and while carbohydrate is shuttled in to refill glycogen stores. By activating this carrier-driving mechanism, anabolic muscle growth rate and recovery remarkably increased. Therefore, a minimal protein requirement is 10.5 g, 21.0 g, 31.5 g, 42.0 g protein for 1, 2, 3, or 4-hour exercise sessions, respectively. Complete glycogen replacement may require 3-5 days from adequate complex carbohydrate-rich meals based on training intensity expense and individual biochemistry.

THE FUEL RESOLUTION

[Perpetuum](#) supplies 6 grams protein for each 260 calorie/hour serving and [Sustained Energy](#) supplies nearly 8 grams protein in each 260-calorie/hour serving. Not consuming protein during exercise imposes a net loss of at least -10.5 grams protein at a slow easy pace (6% protein calories burned per hour). By consuming 260 calories [Perpetuum](#) or [Sustained Energy](#) each hour during exercise, these protein deficits are blunted from -10.5 grams/hour to -4.5 grams and -2.6 grams, respectively. The protein deficit is resolved by a high protein meal replacement following exercise. The recommended resolution is consume 2-4 scoops [Recoverite](#) immediately following exercise (Figure 2):

FIGURE 2 - PROTEIN REPLACEMENT PER HOUR EXERCISE



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- [5] Fielding RA, Parkington J. What are the dietary protein requirements of physically active individuals? New evidence on the effects of exercise on protein utilization during post-exercise recovery. *Nutr Clin Care*. 2002 Jul-Aug; 5(4):191-6. Review.
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- [8] *J Physiol* 2001 Aug 15;535(Pt 1):301-11.
- [9] Evans WJ. Protein nutrition, exercise and aging. *J Am Coll Nutr*. 2004 Dec; 23(6 Suppl):601S-609S.
- [10] Yarasheski KE. Exercise, aging, and muscle protein metabolism. *J Gerontol A Biol Sci Med Sci*. 2003 Oct;58(10):M918-22. Review.