Re-thinking Protein Needs

A growing body of research reveals that dietary protein intakes above minimum requirements are beneficial in maintaining muscle function and mobility and in the treatment of age-related diseases.

by Dr. Donald K. Layman

The controversy about dietary needs for protein stems from current perceptions that protein intakes above minimum requirements have no benefit and may pose long-term health risks. These beliefs are largely based on assumptions and extrapolations with little foundation in nutrition science. Diets with increased protein improve adult health with benefits for treatment or prevention of obesity, type 2 diabetes, Metabolic Syndrome (MetS), osteoporosis, sarcopenia, and heart disease. Key findings leading to the re-thinking of protein needs are the discovery of increased need of adults for high quality protein, the role of the essential amino acid leucine in protecting skeletal muscle, and the importance of the right amounts of protein at specific meals. Current perceptions are that protein is an expensive nutrient with limitations in the food supply that led to requirements based on cost/benefit measurements. This concept stems from commercial agriculture desire to maximize weight gain with the least expensive foodstuff. Animal feeding practices focus on providing cheap carbohydrates as the primary energy source and limiting dietary protein to the minimum amount to sustain growth. Even measures of protein quality are based on efficiency of growth (Protein Efficiency Ratio) and nitrogen balance (Net Protein Utilization). No other nutrient is evaluated based on efficiency of getting the largest effect for the least amount. For human health, the goal should be optimal health and not least cost.

Emerging Roles

During the past decade, a growing body of research reveals that dietary protein intakes above minimum requirements are beneficial in maintaining muscle function and mobility and in the treatment of age-related diseases, particularly obesity, osteoporosis, and sarcopenia. The new research establishes health benefits and provides molecular evidence of numerous metabolic outcomes associated with protein intake or amino acid metabolism that are not reflected in the current Recommended Dietary Allowance (RDA). These outcomes include the unique metabolic role of the branched-chain amino acid leucine, stimulation of calorie expenditure (thermogenesis), control of hunger (satiety), and stabilizing blood sugar (glycemic control). Part of the re-evaluation of protein needs comes from the realization that skeletal muscle is a critical factor for adult health. More adults over the age of 65 die from disability and associated hospitalization than from heart disease and cancer combined. Aging, limited physical activity, extended bed rest, and rapid weight loss are threats to muscle health. Loss of muscle mass and function limits mobility and reduces the metabolically active tissue of the body resulting in reduced capacity to burn calories, increased fat storage, and greater insulin resistance. Maintaining muscle health is critical for healthy aging.

Current protein requirements are established to prevent deficiencies and reflect a minimum need for protein. The RDA is defined as "the minimum daily needs for protein to

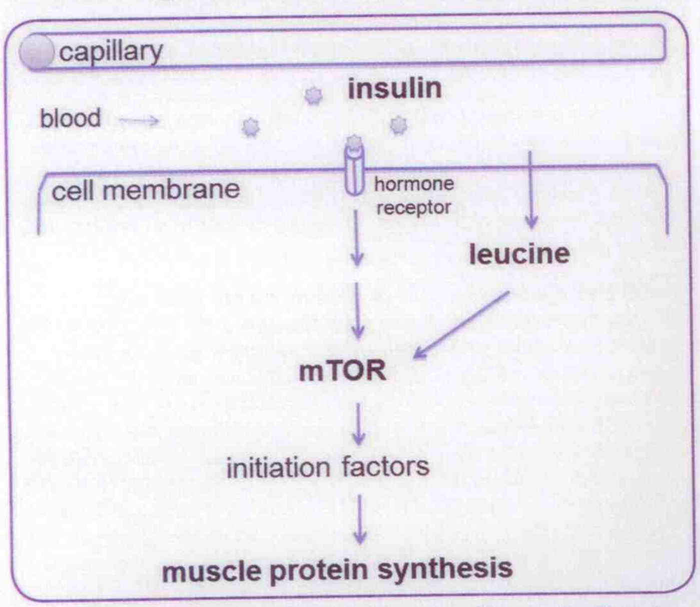

Figure 1: Integration of Insulin and Leucine Signals for Protein Synthesis

Source: Innova Market Insights

Ensure High Protein Shake with Homemade Vanilla Flavor (US) contains, "50% daily value of protein to help stay active and strong."

maintain short-term nitrogen balance in healthy people with moderate physical activity." Nitrogen balance is a sensitive measurement during growth but for non-growing adults it is largely a measure of changes in the liver and intestinal tract. The RDA does not define an optimal protein need for long-term health, but simply a minimum amount to prevent deficiencies.

Simplistic View

A long-held belief in nutrition has been that non-growing adults require very little dietary protein leading to the myth that "adults eat more protein than they need." This statement is based on the simplistic view that the only purpose of dietary protein is to provide amino acids as building blocks for new proteins and growth. This concept is a "substrate" requirement for protein. If you are building new proteins for growth, then you require more building blocks. This concept is easy to teach in beginning nutrition, but does not reflect the diverse metabolic roles for amino acids or the increased need for essential amino acids (EAA) to maintain muscle health in adults.

While children are growing and adding muscle mass, the maximum daily protein gain is less than 5 grams each day. Daily protein intake may be 60 grams or 120 grams but growth is still about 5 grams per day. The primary role of protein synthesis is not for growth but to repair and replace existing body proteins. Both a growing adolescent and a mid-life adult synthesize approximately 250 grams of new proteins every day and they breakdown (or destroy) 250 grams of protein. This continuous cycling of body proteins is called protein turnover and is an essential part of healthy aging. Growth represents less than 2% of total daily protein turnover.

Reduced Efficiency

Another factor increasing adult protein needs is reduced efficiency of amino acid use. To get the same rate of muscle protein turnover, adults need at least 30% more EAA. The reason for the reduced efficiency of amino acid use remains unclear. It may relate to reduced capillary blood flow slowing the delivery of amino acids to muscle, reduced rates of membrane transport of amino acid, or decreased sensitivity to hormone and nutrient signaling systems. Whatever the cause, aging increases the need for EAA to maintain muscle health. These EAA can be obtained either by eating more total protein or eating higher quality protein containing more EAA.

An important change in dietary guidelines occurred in 2002, when the Institute of Medicine of the National Academy of Sciences published the Dietary Reference Intakes (DRIs). The DRI established that healthy intake of any nutrient was a range of intakes beginning at the RDA as the lowest intake that prevented known deficiencies and increasing to an Upper Limit where there may be adverse effects of excess. For protein the range is known as the Acceptable Macronutrient Distribution Range (AMDR) and begins with the RDA of 0.8 grams/kilogram body weight daily (0.8g/kg/day), with a range up to at least 2.5g/kg/day without any identifiable Upper Limit risk.

Critical Signal

An explanation of the increased protein need for adult health is being unraveled and appears to relate to the amount of EAA and particularly the amount of leucine at each meal. Leucine is a critical nutrient signal for triggering initiation of muscle protein synthesis. Muscle appears to recognize the level of leucine in the blood as a signal that the meal contains adequate protein to sustain protein turnover. Leucine has been well characterized as a unique regulator of the insulin-mTOR signal pathway controlling synthesis of muscle proteins (figure 1). In children and young adults, this signal pathway is regulated by growth hormones such as insulin and IGF-1 plus dietary energy in the form of carbohydrates. When growth ends, primary regulation of the pathway shifts to leucine and the protein content of the meal.

Current dietary guidelines define protein needs as a daily requirement. The RDA (0.8 g/kg/day) minimizes the importance of protein as a central part of every meal resulting in meal patterns in the US, with over 65% of protein consumed in a single large meal after 6:30 pm. Most adults consume less than 12g of protein at breakfast (figure 2). In children and young adults, uneven meal distribution of protein appears not to adversely affect growth. The anabolic drive of growth hormones maintains high efficiency of protein use for nitrogen retention even when daily protein is consumed as a single large meal. However in older adults, the quantity and quality of proteins at individual meals become the critical factors.

Stimulating muscle protein synthesis for adults requires about 2.5 grams to 3.0 grams of leucine. This amount of leucine translates to a minimum of 15g of EAA or approximately 30g of protein at a meal. Once the process of protein synthesis is triggered by leucine, then all of the EAA are required as the building blocks to complete synthesis of a protein, but the key is providing adequate leucine to trigger initiation of the process.

Satiety Impact

The meal content of protein is also a key factor for satiety and appetite regulation. Protein has greater satiety value than either carbohydrates or fats and reduces food intake at subsequent meals. Studies of energy regulation for weight management show that replacing carbohydrates with protein reduces daily energy intake by ~200 kcal. The mechanism for this satiety effect may be mediated by intestinal hormones or by reducing peak post-prandial insulin response. While the mechanism remains to be elucidated, it is clear that the improved satiety response requires >30g of protein at a meal and that breakfast has the greatest impact on total daily

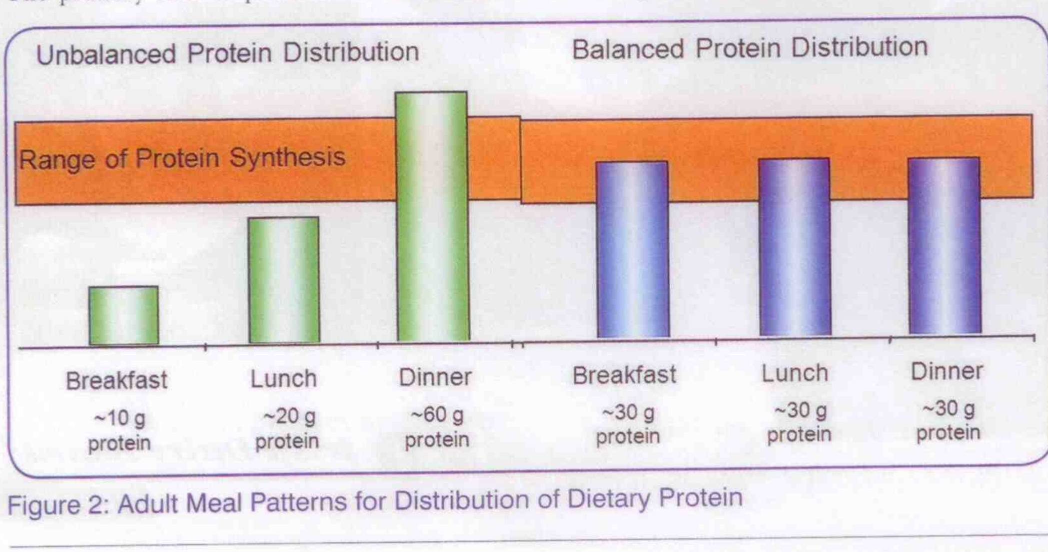

Figure 2: Adult Meal Patterns for Distribution of Dietary Protein

energy intake. Limiting protein intake to a single large meal late in the day reduces the satiety benefits of dietary protein.

The leucine threshold to trigger muscle protein synthesis is a critical factor in evaluating the quantity and quality of protein necessary at a meal. Meals that contain less than 2.5 grams of leucine or approximately 30 grams of protein fail to stimulate muscle protein synthesis. So while these small meals may increase protein content in the liver or intestinal tract, meals with less than 30 grams of protein provide no benefit to the large muscle mass of the body.

The importance of the leucine discovery is most important at small meals such as breakfast when the size of the meal and total amount of protein are limited. Dinner typically contains a protein-dense entree like meat. One ounce of meat contains about 0.6 grams of leucine and requires at little as 4 ounces of cooked meat to fully trigger protein synthesis.

Leucine Sources

The richest sources of leucine are animal proteins. Whey protein is unusually high in leucine with approximately 11% (per gram of protein), which makes it the protein of choice used in supplements for athletes and body builders seeking maximum muscle performance. In general, animal proteins including dairy, eggs and meats contain more leucine and have a more complete balance of EAA than plant proteins such as wheat, oats and soy. Again, this distinction is important at small meals. Many Americans consume cereal for breakfast with high carbohydrates and low protein. These breakfasts typically contain less than 12 grams of protein, with 50% of the protein derived from wheat gluten, which contains only 6.8% leucine per gram of protein. The low protein content of breakfast fails to provide sufficient leucine to stimulate muscle protein synthesis and allow the body to recover from the nighttime period of fasting. Preliminary research from our laboratory shows that the breakfast meal is critical for maintaining skeletal muscle and healthy body composition in adults. Another important finding is the meal response for protein synthesis lasts about three hours. If dinner is the only meal that contains adequate total protein and sufficient leucine to trigger muscle protein synthesis, then the body is in a positive or an anabolic state for only three hours each day after dinner, but in a negative or catabolic condition for 21 hours. This pattern of eating is very detrimental during weight loss or bed rest and likely leads to slow loss of lean tissue during aging.

Weight Loss

The most unequivocal evidence for the benefit of increased dietary protein and the importance of meal distribution is derived from studies of weight management. Diets with increased protein have been shown to be highly beneficial during weight loss because of their ability to correct body composition and increase satiety and thermogenesis. Higher protein diets increase loss of body weight and body fat and attenuate loss of lean tissue when compared with commonly recommended high carbohydrate low fat low protein diets.

Clearly, the major factors accounting for weight loss are the magnitude of energy restriction and individual compliance. Any diet can produce weight loss. However, long-term success with weight loss relates to maintenance of metabolically active lean tissues and research has proven that higher protein diets protect muscle and bone during weight loss. Use of conventional high carbohydrate, low fat, low protein diets results in 30% to 40% loss of lean tissue mass. Use of higher protein diets reduces lean tissue loss to <15% and when combined with exercise can halt loss of lean tissue during weight loss. Studies also show that moderate protein diets have better long-term compliance.

Combating Aging

The effects of protein for maintaining lean tissues appear to translate into health benefits during aging where progressive loss of structural strength and mobility are critical factors. Osteoporosis and sarcopenia have emerged as major issues during aging. Prevention of osteoporosis is associated with physical activity and dietary calcium and protein. The efficacy of calcium and protein are interrelated. Calcium supplements are largely ineffective for remodeling of bone matrix if protein is limited. Positive effects of calcium appear to require intakes of protein greater than 1.2g/kg/day to have beneficial effects. The long-held belief that increased dietary protein could cause bone loss as reflected in increase urinary calcium is incorrect and protein is now recognized to increase intestinal calcium absorption in addition to enhancing bone matrix turnover.

Similar results have been observed with studies of muscle health in elderly where the efficiency of EAA use is reduced. The level of EAA required to stimulate muscle protein synthesis is increased in part due to reduced anabolic stimulus of hormones. Here again it is important to distinguish the difference between outcome measures of muscle protein metabolism versus nitrogen balance. Long-term prospective outcomes with protein supplementation and muscle function are not available. However cross-sectional studies support the idea that elderly in higher percentiles of protein intake have less age-related decline in lean tissue mass.

Protein Rethink

New research about the importance of skeletal muscle in treatment or prevention of obesity, diabetes, sarcopenia, and osteoporosis have led to a re-thinking about the role of dietary protein in adult health. New goals that emphasize at least 30 grams of protein at two or more meals with an emphasis on breakfast and with the quality of protein measured by the leucine content are likely the future standards for adult health.♦

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