

## Proteins, Amino Acids and Muscle Protein Synthesis

Proteins are broken down by the digestive system into 21 amino acids. Among these there are 8 essential amino acids which cannot be made in the body but must be consumed in the diet and 13 non-essential amino acids. Amino acids are needed to stimulate muscle protein synthesis (MPS), but this only occurs in conjunction with resistance exercise. MPS is stimulated when the concentration of amino acids is higher in the blood infusing a muscle than it is inside the muscle cells. When the concentrations of the amino acids are lower in the blood than in the muscle as can happen between meals or while you are sleeping then MPS will not be stimulated and muscle breakdown will occur. Therefore, amino acid availability is a potent regulator of MPS. A series of studies done in 2002 by Robert Wolfe and colleagues (1) used non-radioactive stable isotope-labeled amino acids. For example there are Carbon atoms with an atomic weight of 13 which can be obtained from nuclear reactors and chemically substituted into amino acids for the normal Carbon atom with an atomic weight of 12. The heavy carbon can then be detected in a mass spectrometer. By studying the concentration of amino acids with Carbon 13 in the blood and in muscle proteins it is possible to examine the response of MPS, muscle breakdown, and the balance between synthesis and breakdown to changes in the availability of amino acids. A constant intake of amino acids stimulated MPS in a dose-dependent manner until concentrations were approximately doubled, after which further increases in concentration led to no further increase in MPS. MPS rose more rapidly after a single large dose of amino acids to a peak rate of MPS higher than during constant concentration of amino acids in the same total amount, but the MPS response was short-lived and decreased after the peak was reached even while amino acid levels were still high suggesting the system had been maximally stimulated at the peak. A reduction in amino acid availability below basal levels inhibited MPS. Ingestion of nonessential amino acids was not needed to stimulate MPS. When carbohydrate alone was ingested there was a minimal effect on MPS, but there is an interactive effect with amino acid ingestion, meaning the response to amino acids plus glucose is more than the sum of their individual effects. The classic studies above have been confirmed repeatedly and establish the general principles of how protein in the diet stimulates muscle protein synthesis after exercise.

Wolfe RR. Regulation of muscle protein by amino acids. *J Nutr.* 2002;132:3219S-24S.