Branched-Chain Amino Acids in Exercise

Introduction to Symposium on Branched-Chain Amino Acids in Exercise1,2

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The use of protein and amino acids to improve muscle mass and physical performance in athletes has been a topic of considerable interest to sports nutritionists. Behind this application, are a number of issues of current scientific interest. First is the question of how physical training modifies muscle protein synthesis and breakdown, and whether and how changes in protein and amino acid consumption in the diet might influence these processes. Second is the issue of whether and how dietary amino acids and protein, consumed in advance of physical exertion, might affect physical performance. Fatigue is an important factor that influences physical performance and has two components, peripheral and central. Peripheral fatigue relates to those aspects of metabolism and physiology that directly affect muscle tissue (nutritional, hormonal, and mechanical); central fatigue relates specifically to the neuronal inputs to striated muscle (voluntary motor neurons) and the brain circuitry that drives them (1). Dietary amino acids and protein have been examined for their effects on peripheral and central fatigue, particularly from the metabolic and neurochemical perspectives. And third, while current metabolic evidence indicates that dietary protein influences muscle function, such effects may be attributable to the intake specifically of all or some essential amino acids (2).

This symposium considered each of these issues, as presented in the following articles: Robert Wolfe, Yoshiharu Shimomura, Robert Layman, and Masaru Ohtani discuss dietary protein and amino acid intake in relation to muscle protein and amino acid metabolism during and after exercise, as well as the effects of these dietary intakes on muscle fatigue, damage, and recovery. Eva Blomstrand, Kunio Torii, and John Fernstrom consider the impact of exercise on the brain as it relates to the issue of central fatigue. Dr. Wolfe discusses, in particular, the effects of exercise and amino acid intake on muscle protein accretion in response to resistance exercise. The results of studies in humans using stable isotope techniques indicate that resistance exercise and dietary amino acids have an interactive effect in promoting net protein anabolism in response to exercise. Dr. Shimomura discusses the metabolism of BCAAs, in muscle, and the key role of the branched-chain α-keto-acid dehydrogenase (BCKD) complex in governing this process. He further examines the possible mechanisms by which an increase in the dietary supply of BCAAs during exercise might moderate muscle damage and promote recovery. Dr. Layman considers the biochemical role that leucine plays in stimulating muscle protein synthesis through activation of the mammalian target of rapamycin (mTOR) protein kinase pathway. He discusses the effects of exercised-induced increases in BCAA metabolism and the ingestion of BCAA at the time of exercise on muscle leucine pools and mTOR-mediated protein synthesis. Dr. Ohtani then reviews studies of endurance training, and the effects of dietary amino acids on the muscle fatigue, damage, and recovery as experienced by athletes in endurance training programs. Dr. Blomstrand presents the notion of central fatigue, and develops the possible role of brain serotonin (5HT) neurons in its emergence during exercise. She then discusses the metabolic changes that occur with exercise that may stimulate 5HT synthesis and release by brain neurons and, as a consequence, precipitate central fatigue. She further considers how the ingestion of BCAA might prevent the increase in 5HT that occurs during exercise, and thus diminish central fatigue and enhance physical performance. Dr. Torii presents direct biochemical evidence in rats demonstrating that brain neurons release increased amounts of 5HT during treadmill exercise, and that the effect is attenuated by the ingestion of an amino acid solution containing BCAAs. Finally, Dr. Fernstrom discusses the data used to support the mechanisms by which exercise is argued to stimulate 5HT synthesis in and release by brain neurons. He then discusses further approaches that could be taken to test the notion that 5HT neurons generate central fatigue during exercise.

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