ACTIVE LIFESTYLE > SPORTS NUTRITION

MuscleMania: Nutrition for Beefing Up the Bod

Protein is the obvious nutritional king of muscle builders, but specific amino acids have been singled out as more important than others at initiating muscle protein synthesis.

Steve Myers | Jul 02, 2018

Every consumer approaches muscle building differently. Some want every skeletal muscle to bulge out as big as humanly possible. Some just want to tone the right muscles for their sport or active pursuits, without adding too much bulk. A lot of consumers are somewhere in between.

The simple muscle math is this: when muscle protein synthesis (MPS) outpaces muscle protein breakdown (MPB), new muscle is built. In a nutshell, exercise damages muscle fibers; the body repairs damaged fibers and forms new muscle protein strands called myofibrils. In

a nutshell, exercise damages muscle fibers, the body repairs damaged fibers and forms new muscle protein strands called myofibrils. In the sports nutrition world, this is called muscle adaptation, and new muscles are called gains.

Protein is the obvious nutritional king of muscle builders, but specific amino acids have been singled out as more important than others at initiating MPS, and numerous other natural ingredients have shown promising impacts on muscle growth, signaling and delivering more muscle-building nutrients to the skeletal muscles.

Muscle Nutrition

Dietary protein contains amino acids for building new muscle. This role has made protein the top sports nutrition ingredient. Dairy and animal proteins have dominated the sports market, as these are "complete" proteins, meaning they contain each of the nine essential amino acids (EAAS) that the body can't produce.

Among the dairy proteins, **whey** is a considered a fast-acting protein, making it ideal for use on the envelope of exercise, while **casein** is a slow-acting protein considered useful for keeping the body flush with amino acids overnight or during longer-term recovery.

Most plant protein ingredients—**pea**, **rice**, **hemp** and **flax**—are from sources missing or insufficient in one or more EAAs. Formulators have considered blending two or more of these plant sources to deliver a complete protein or to maximize key amino acids such as leucine. **Soy** is a complete protein, as is a new protein ingredient from **water lentils** or duckweed (Lentein®), according to the supplier Parabel.

The **branched chain amino acids** (BCAAs)—leucine, isoleucine and valine—are EAAs considered by many sports nutrition experts as crucially important for muscle building, with **leucine** enjoying a special spotlight.

According to current scientific knowledge, the primary regulator of MPS is the mammalian target of rapamycin (mTOR) signaling pathway—this protein kinase is found in skeletal muscles as mTOR or mTOR complex 1 (mTORC1). The prevailing theory is leucine activates mTOR signaling for muscle growth more significantly than do the other BCAAs and EAAs.

The threshold of 1.7 g to 3.5 g of leucine is the proposed target, above which no significant additional muscle growth is experienced.

"Whey protein isolate (>90 percent protein) delivers around 8.4 percent leucine, and pea protein concentrate (>80 percent protein) delivers around 5.6 percent leucine," noted Corbin Hohl, research scientist, Glanbia Nutritionals. "That being said, pea protein offers a strong plant protein option that pairs well with other plants proteins, dairy proteins or free form amino acids to hit target levels."

Many companies try to boost leucine content of protein ingredients/formulations or add leucine to a protein formula.

Research (*Nutrients*. 2016 Apr; 8(4):181) has shown adding leucine to casein increases postprandial MPS, whereas adding leucine to whey protein produced similar MPS stimulation, as did whey protein alone. The researchers confirmed adding leucine to protein sources already containing sufficient leucine content provided no additional benefit to MPS.

Some protein ingredient suppliers have highlighted increased leucine content. International Dehydrated Foods (IDF) noted each 30 g scoop of its CHiKPRO™ chicken protein isolate contains 25 g of protein, including 7.5 g of leucine. On the plant side, Lentein contains 5 g of leucine per dose.

Leucine can be metabolized in skeletal muscle, and its metabolites may possess similar anabolic properties. One such metabolite is **HMB** (beta-hydroxy-beta-methylbutyrate), which has demonstrated the potential (*J Physiol*. 2013 Jun 1;591(Pt 11):2911–2923) to stimulate MPS and inhibit MPB to encourage lean body mass development following exercise. A combination of leucine, HMB and phosphatidic acid (PA, as Mediator®, from Chemi Nutra) increased lean muscle mass and muscle strength better than exercise alone (*JISSN*. 2016;13:24).

A combination of amino acids **alanine** and **glutamine** (as Sustamine®, from Kyowa Hakko) limits MPB and, when taken with MPS-stimulating whey protein, provides this same one-two punch for muscle growth.

Insulin similarly works both sides of the muscle development equation. When complete proteins or EAAs are present, insulin can stimulate MPS, while in a low-EAA status insulin inhibits MPB. Protein synthesis stimulates production of insulin, thereby increasing glucose levels in muscles—insulin's primary job is to store glucose in muscle or fat. Increased insulin improves amino acid uptake in muscles.

The mineral chromium is well-known for its ability to improve insulin resistance and insulin sensitivity in cells. A **chromium-amylopectin** combination (as Velositol™, from Nutrition 21) paired with whey protein supplementation and resistance exercise can boost post-workout MPS better—as much as two times—than whey alone, according to recently published research (*JISSN*. 2017 Feb;14:6). The researchers noted amylopectin's role is as a transporter.

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In addition to impacting insulin sensitivity, chromium might also enhance myokines (e.g. musclin and fractalkine), signaling molecules released in muscles that promote increased MPS from exercise (*Amer Coll Nutr*. 2017;112(52):16047).

Growth factors, including hormones such as insulin growth factor (IGF), stimulate repair of damaged muscles. Exercise prompts the release of growth factors, which regulate activities of muscle satellite cells that mature or differentiate into new muscle proteins.

IGF-1 is a well-known trigger of mTOR signaling in muscle. This drove companies to offer synthetic IGF as sports supplements, which was not legal. However, IGF-1 is found naturally in **deer antler velvet**, where it promotes growth of the animal's antlers. Research on the muscle development benefits of deer antler supplementation in humans has been limited and offered mixed results.

IGF-1 in humans increases when human growth hormone (HGH) increases. Where IGF stimulates muscle growth, HGH primarily stimulates bone and connective tissue growth. IGF synergistically interacts with testosterone to stimulate MPS (*J Clin Endocrin Metab*. 2000 April;85(4):1627-1633).

Testosterone is a steroid hormone that can affect numerous parts of the body including the heart and skeletal muscles, as well as metabolism. Low testosterone encourages weight gain and glucose/insulin problems, but increased levels of testosterone can make muscles grow.

This steroid hormone is anabolic, directly stimulating MPS by increasing the presence of muscle satellite cells and inhibiting hormones that promote MPB.

The body makes testosterone, but levels wane after a peak in the early 20s. Testosterone is a controlled drug in the United States and other countries, and is banned by sporting bodies around the world. However, natural ingredients have shown promise as testosterone boosters, catching the eye of many in the sports nutrition market.

Steroidal phytochemicals in the seeds of **fenugreek** (*Trigonella foenum-groecum* L.) include glycosides and diosgenin, which are thought to boost testosterone and glucose metabolism, respectively. Fenugreek supplementation (as Testofen®, from Gencor Pacific) has increased both total serum testosterone and free testosterone in healthy men (43 years and older), compared to placebo (*Aging Male*. 2016 Jun;19(2):134-42). This action may increase muscle strength and promote anabolic activity (*J Sport and Health Sci*. 2016;5(2):176-82).

Driving Muscles

MPS and mTOR signaling cannot make better muscles without adequate delivery of nutrients and adequate muscle function during exercise.

Resistance exercise is typically anaerobic. Fuel for anaerobic exercise comes from stored, readily available ATP (adenosine triphosphate)—breaking the phosphate bonds of this molecule transfers energy to cells.

Phosphocreatine stored in muscles can be used to quickly restore ATP and fuel short periods of anaerobic exercise, such as weight lifting. Supplemental **creatine** boosts muscle levels of phosphocreatine and can extend this period of anaerobic energy, potentially leading to more reps. By improving muscle endurance, creatine can increase lean muscle mass and strength.

Increasing muscle ATP using a combination of **ancient peat** and **apple polyphenols** (as elevATP®, from Futureceuticals) was shown to beneficially augment power and strength adaptations to resistance training (*BMC Comp Alt Med*. 2016 July; 16:224). The combo may impact irisin, a myokine that activates satellite cells and MPS, but the supplement has ability to improve blood flow and provide more substrate for the phosphagen system (creatine phosphate).

Limiting fatigue in muscles can have a similar effect. Carnosine buffers hydrogen ions that can accumulate in muscles as a byproduct of glycolysis, the process of turning glucose into ATP—this process spans both anaerobic and aerobic exercise states.

Beta-alanine is a precursor to carnosine. When taken as a supplement, beta-alanine combines with histidine to form carnosine.

While fuel is necessary for muscle to work, muscles cannot contract without proper signals from the brain. The neurotransmitter acetylcholine is the brain's messenger for muscle contractions. Acetylcholine travels across the neuromuscular junction, the bridge between motor neurons and muscle fibers, and signals muscles to contract.

The body manufactures acetylcholine from **choline** supplies in the blood, which come from dietary choline—liver, eggs and peanuts are

high in choline; fish, beef and other meats and dairy also supply good choline content.

Krill contains phosphatidylcholine (PC), phosphatidic acid and astaxanthin, which all affect muscle development. Krill oil activates mTOR signaling in resistance trained men (*J Nutr Metab*. 2018:7625981).

Plants like spinach and beets are rich in the choline metabolite **betaine**, which improves muscle endurance, strength and power. Among possible mechanisms behind betaine's muscle benefits are activation of insulin signaling pathways and IGF-1 release, as well as stimulation of growth hormone secretion, creatine synthesis and MPS (*Amino Acids*, 46(8), 2014).

The amino acid **arginine** also signals muscle cells to release growth hormones. Arginine is popularly known as a precursor nitric oxide (NO), a vasodilator—it relaxes blood vessel walls to increase blood flow. Improved blood flow to muscles brings important nutrients to them and both facilitates longer workouts and increases muscle volume (called "pump").

A combination of arginine, silicon and inositol (as Nitrosigine®, from Nutrition 21) elevates blood levels of arginine and NO (*Clin Pharmacol*. 2015;7:103–109). This action can boost muscle pump and combat muscle damage (*JISSN*. 2015;12(Suppl 1):P14).

Nitrates boost NO and are found in many root vegetables, including beets. Supplemental nitrates in combination with sprint interval training increased the proportion of type II muscle fibers (*Front Physiol*. 2016; 7: 233).

Nitrates from short-term **beetroot** supplementation can improve physiological and functional responses in type II muscle fibers (J *Appl Physiol* 2015 Jun 1;118(11):1396-405). Nitrate-rich beetroot extract supplementation during heavy resistance exercise may provide neuromuscular benefits, including firing rates (*J Am Coll Nutr*. 2016;35(2):100-7).

The crux of muscle building may be on boosting MPS and limiting MPB, and delivering the right EAAs to muscles post-exercise—popularly via protein intake—may be the primary supplementation target, but energizing muscles, maintaining good muscle function and maximizing nutrient delivery to muscles are all important aspects to consider when developing a muscle-building product. Surely, protecting muscle from exercise-related antioxidants and inflammation may also be a consideration, which would open muscle-building formulations up to an even wider range of supportive ingredients. As always, the key is research on specific activities and benefits.

A Note About SARMs

Selective androgen receptor modulators (SARMs) became the big muscle-building category after the U.S. Congress effectively rid the market of prohormones in 2014. The allure of SARMs was the promise of exploding muscle growth via anabolic activation with much less androgenic side effects often experienced with the use of anabolic steroids, including testosterone.

SARMs have been under development by several pharmaceutical companies for specific disease or medical uses such as muscle and bone loss, prostate enlargement and birth control. FDA has advised SARMs are not legal dietary ingredients and, therefore, cannot legally be sold as dietary supplements. The agency sent warning letters to several sports nutrition companies selling SARMs as supplements, and has raided at least one major sports nutrition company selling SARMs online via many different sites, including research chemicals.

"Life threatening reactions, including liver toxicity, have occurred in people taking products containing SARMs," FDA stated, in a press release. "SARMs also have the potential to increase the risk of heart attack and stroke, and the long-term effects on the body are unknown."

One sports nutrition industry company, Nutrition Distribution, has filed Lanham Act lawsuits against supplement companies selling SARMs, alleging unfair competition. However, hardcore bodybuilders and biohackers have sworn by SARMs and continue to take them, and there continue to be online sources of SARMs, some from overseas—China is considered a primary source of SARMs ingredients.

The SARMs originally developed for pharmaceutical targets, is the forms primarily sold to muscle-building consumers, are not from plant origin but were made by tweaking testosterone. Later, nonsteroidal SARMs were chemically developed. However, there have been attempts to sell sports supplements claiming to contain plant-based "SARMs" (called pSARMs or phytoSARMs). The focus of these products is on DHEA-derived prohormones and bark extracts that are claimed to have SARM-like actions.

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