

Bodybuilding supplement

From Wikipedia, the free encyclopedia

Bodybuilding supplements are dietary supplements specifically marketed to those involved in bodybuilding, weightlifting and athletics. Among the most widely used are vitamins, protein, branched-chain amino acids (BCAA), glutamine, essential fatty acids, meal replacement products, creatine, weight loss products and testosterone boosters. Supplements are sold either as single ingredient preparations or in the form of "stacks" - proprietary blends of various supplements marketed as offering "synergistic advantages". While many bodybuilding supplements are also consumed by the general public, their salience and frequency of use may differ when used specifically by bodybuilders. They may be marketed as a product to replace meals, enhance weight gain, promote weight loss or improve athletic performance. Annual sales of sport nutrition products in the US is over \$2.7 billion (US) according to *Consumer Reports*.^[1]

Contents

- 1 History
- 2 Controversy
 - 2.1 Mislabeling and adulteration
 - 2.2 Health problems
 - 2.2.1 Liver damage
 - 2.3 Lack of effectiveness
- 3 Supplement categories
 - 3.1 Protein
 - 3.1.1 Amino acids
 - 3.2 Essential fatty acids
 - 3.3 Prohormones
 - 3.4 Creatine
 - 3.5 β-Hydroxy β-methylbutyrate
 - 3.6 Meal replacement products
 - 3.7 Thermogenic products
- 4 See also
- 5 Notes
- 6 References
- 7 External links

History

Athletes in ancient Greece were advised to consume large quantities of meat and wine. A number of herbal concoctions and tonics have been used by strong men and athletes since ancient times across cultures for the enhancement of strength, vigor, prowess and stamina.^[2] In the 1910s, Eugen Sandow, widely considered to be the first modern bodybuilder in the West, advocated the use of dietary control to enhance muscle growth. Later, bodybuilder Earle Liederman advocated the use of "beef juice" or "beef extract" (basically, consomme) as a way to enhance muscle recovery. In 1950s with recreational and competitive bodybuilding becoming increasingly popular Irvin P. Johnson began to popularize and market egg-based protein powders marketed specifically at bodybuilders and physical athletes. The 1970s and 1980s marked a dramatic increase in the growth of the bodybuilding supplement industry, fueled by widespread use of modern marketing techniques and a marked increase in recreational bodybuilding.

In October 1994, the Dietary Supplement Health and Education Act (DSHEA) was signed into law in the USA. Under DSHEA, responsibility for determining the safety of the dietary supplements changed from government to the manufacturer and supplements no longer required approval from the U.S. Food and Drug Administration (FDA) before distributing product. Since that time manufacturers did not have to provide FDA with the evidence to substantiate safety or effectiveness unless a new dietary ingredient was added. It is widely believed that the 1994 DSHEA further consolidated the position of the supplement industry and lead to additional product sales.^[3]

Controversy

Mislabeled and adulteration

According to University of Helsinki food safety professor Marina Heinonen, more than 90% of dietary supplement health claims are incorrect.^[4] While many of the claims are based on scientifically based physiological or biochemical processes, their use in bodybuilding parlance is often heavily colored by bodybuilding lore and industry marketing and as such may deviate considerably from traditional scientific usages of the terms. In addition, ingredients listed have been found at times to be different from the contents. In 2015, Consumer Reports reported unsafe levels of arsenic, cadmium, lead and mercury in several of the protein powders that were tested.^[5]

In the United States, the manufacturers of dietary supplements do not need to provide the Food and Drug Administration with evidence of product safety prior to marketing.^[6] As a result, the incidence of products adulterated with illegal ingredients has continued to rise.^[6] In 2013, one-third of the supplements tested were adulterated with unlisted steroids.^[7] More recently, the prevalence designer steroids with unknown safety and pharmacological effects has increased.^{[8][9]}

In 2015 a CBC investigative report found that protein spiking (the addition of amino acid filler to manipulate analysis) was not uncommon,^[10] however many of the companies involved challenged these claims.^[11]

Health problems

The US FDA reports 50,000 health problems a year due to dietary supplements^[12] and these often involve bodybuilding supplements.^[13] For example, the "natural" best-seller Craze, 2012's "New Supplement of the Year" by bodybuilding.com, widely sold in stores such as Walmart and Amazon, was found to contain N,alpha-Diethylphenylethylamine, a methamphetamine analog.^[14] Other products by Matt Cahill have contained dangerous substances causing blindness or liver damages, and experts say that Cahill is emblematic for the whole industry.^[15]

Liver damage

The incidence of liver damage from dietary supplements has tripled in a decade, the majority of these involved bodybuilding supplements. This resulted in liver transplants and, in some cases, death to the patient. Some have argued that the liver damage is more often caused by prescription drugs rather than supplements.^[7]

Lack of effectiveness

In addition to being potentially harmful, some have argued that there is little evidence to indicate any benefit to using bodybuilding supplements. For example, according to the IOC, no consensus had been reached in determining whether an individual in exercise training benefits from protein and amino acid supplements.^[16] "In view of the lack of compelling evidence to the contrary, no additional dietary protein is suggested for healthy adults undertaking resistance or endurance exercise".^[17]

Supplement categories

Protein

Bodybuilders may supplement their diets with protein for reasons of convenience, lower cost (relative to meat and fish products) and to avoid the concurrent consumption of carbohydrates and fats. In addition, some argue that bodybuilders, by virtue of their unique training and goals, require higher-than-average quantities of protein to support maximal muscle growth,^[18] however there is no compelling evidence and no scientific consensus for bodybuilders to consume more protein than the recommended dietary allowance.^{[17][19][20][21][22][23][24]} Protein supplements are sold in ready-to-drink shakes, bars, meal replacement products (see below), bites, oats, gels and powders. Protein powders are the most popular and may have flavoring added for palatability. The powder is usually mixed with water, milk or fruit juice and is generally consumed immediately before and after exercising or in place of a meal. The sources of protein are as follows and differ in protein quality depending on their amino acid profile and digestibility:

- Whey protein contains high levels of all the essential amino acids and branched-chain amino acids. It also has the highest content of the amino acid cysteine, which aids in the biosynthesis of glutathione. For bodybuilders whey protein provides amino acids used to aid in muscle recovery.^[25] Whey protein is derived from the process of making cheese from milk. There are three types of whey protein: whey concentrate, whey isolate, and whey hydrolysate. Whey concentrate is 29–89% protein by weight whereas whey isolate is 90%+ protein by weight. Whey hydrolysate is enzymatically predigested and therefore has the highest rate of digestion of all protein types. Whey protein is usually taken immediately before and after a workout^[25]
- Casein protein (or milk protein) has glutamine, and casomorphin. Casein is usually taken before going to bed.^[25]
- Soy protein from soybeans contain isoflavones, a type of phytoestrogen.
- Egg-white protein is a lactose- and dairy-free protein.
- Hemp protein from hemp seed, contains highly-digestible protein, and hemp oil is high in essential fatty acids.
- Rice protein, when made from the whole grain, is a protein source that is highly digestible and allergen free. Since rice protein is low in the amino acid lysine, it is often combined with pea protein powder to achieve a superior amino acid profile.
- Pea protein is a hypoallergenic protein with a lighter texture than most other protein powders. Pea protein has an amino acid profile similar to that of soy, but pea protein does not elicit concerns about unknown effects of phytoestrogens. Pea protein is also less allergenic than soy. Pea protein has high fiber content and has no allergic ingredients and therefore is easy for digestion as compared to whey protein. Pea protein is a slow digesting protein and is able to keep you full longer.



Protein milkshakes, made from protein powder (center) and milk (left), are a common bodybuilding supplement.

Some nutritionists claim that osteoporosis may occur from excessive protein intake because protein can put pressure on the kidneys and lead to bone loss due to calcium leaching.^[1] However, some have suggested that higher calcium excretion may be due to a corresponding increase in protein-induced calcium absorption in the intestines.^{[26][27][28]}

In addition to complete proteins, some supplements will contain protein fragments such as branched-chain amino acids or individual amino acids (such as glutamine). Amino acids are considered to be inferior to whole protein and have been used by some companies to artificially inflate and falsify protein values in their product (protein spiking). Many protein supplements explicitly indicate on the label that no protein spiking has occurred.

Amino acids

Some bodybuilders believe amino acid supplements may benefit muscle development, but consumption of such supplements is unnecessary.^[29]

Essential fatty acids

The essential fatty acids (alpha-linolenic acid and linoleic acid) may be especially important to supplement while bodybuilding; these cannot readily be made in the body, but are required for various functions within the body to take place.

Fatty fish, such as fresh salmon and trout are rich in essential fatty acids and fish oils can also be taken in supplement form.

Flaxseed oil, often sold as a supplement on its own, is an ideal source of alpha-Linolenic acid, which can also be found in walnuts and pumpkin seeds.^[30]

Prohormones

Prohormones are precursors to hormones and are most typically sold to bodybuilders as a precursor to the natural hormone testosterone. This conversion requires naturally occurring enzymes in the body. Side effects are not uncommon, as prohormones can also convert further into DHT and estrogen. To deal with this, many supplements also have aromatase inhibitors and DHT blockers such as chrysin and 4-androstene-3,6,17-trione. To date most prohormone products have not been thoroughly studied, and



Shaker Bottle commonly used to mix supplements. Often has mesh or a metal whisk inside to breakdown lumps in the mixture.

the health effects of prolonged use are unknown. Although initially available over the counter, their purchase was made illegal without a prescription in the US in 2004, and they hold similar status in many other countries. They remain legal, however, in the United Kingdom and the wider European Union. Their use is prohibited by most sporting bodies.

Creatine

Creatine is an organic acid naturally occurring in the body that supplies energy to muscle cells for short bursts of energy (as required in lifting weights) via creatine phosphate replenishment of ATP. A number of scientific studies have shown that creatine can improve strength,^[31] energy,^[32] muscle mass, and recovery times. In addition, recent studies have also shown that creatine improves brain function.^[33] and reduces mental fatigue.^[34] Unlike steroids or other performance-enhancing drugs, creatine can be found naturally in many common foods such as herring, tuna, salmon, and beef.

Creatine increases what is known as *cell volumization* by drawing water into muscle cells, making them larger. This *intracellular* retention should not be confused with the common myth that creatine causes bloating (or *intercellular* water retention).

Creatine is sold in a variety of forms, including creatine monohydrate and creatine ethyl ester, amongst others. Though all types of creatine are sold for the same purposes, there are subtle differences between them, such as price and necessary dosage.

In *The New Encyclopedia of Modern Bodybuilding, 2nd ed.*, author Arnold Schwarzenegger states:

Creatine monohydrate is regarded as a necessity by most bodybuilders. Creatine monohydrate is the most cost-effective dietary supplement in terms of muscle size and strength gains. ... There is no preferred creatine supplement, but it is believed that creatine works best when it is consumed with simple carbohydrates. This can be accomplished by mixing powdered creatine with grape juice, lemonade, or many high glycemic index drinks.^[35]

Some studies have suggested that consumption of creatine with protein and carbohydrates can have a greater effect than creatine combined with either protein or carbohydrates alone.^[36]

β-Hydroxy β-methylbutyrate

When combined with an appropriate exercise program, dietary supplementation with β-hydroxy β-methylbutyrate (HMB) has been shown to dose-dependently augment gains in muscle hypertrophy (i.e., the size of a muscle),^{[37][38]} muscle strength,^{[37][39][40]} and lean body mass,^{[37][39][40]} reduce exercise-induced skeletal muscle damage,^{[note 1][37][38][40]} and expedite recovery from high-intensity exercise.^{[37][41]} HMB is believed to produce these effects by increasing muscle protein synthesis and decreasing muscle protein breakdown by various mechanisms, including activation of the mechanistic target of rapamycin (mTOR) and inhibition of the proteasome in skeletal muscles.^{[39][42]}

The inhibition of exercise-induced skeletal muscle damage by HMB is affected by the time that it is used relative to exercise.^{[37][41]} The greatest reduction in skeletal muscle damage from a single bout of exercise appears to occur when calcium HMB is ingested 1–2 hours prior to exercise.^[41]

Meal replacement products

Meal replacement products (MRPs) are either pre-packaged powdered drink mixes or edible bars designed to replace prepared meals. MRPs are generally high in protein, low in fat, have a low to moderate amount of carbohydrates, and contain a wide array of vitamins and minerals.

The majority of MRPs use whey protein, casein (often listed as calcium caseinate or micellar casein), soy protein, and/or egg albumin as protein sources. Carbohydrates are typically derived from maltodextrin, oat fiber, brown rice, and/or wheat flour. Some MRPs also contain flax oil powder as a source of essential fatty acids.

MRPs can also contain other ingredients, such as creatine monohydrate, glutamine peptides, L-glutamine, calcium alpha-ketoglutarate, additional amino acids, lactoferrin, conjugated linoleic acid, and medium-chain triglycerides.

A sub-class of MRPs are called 'weight gainers' and have a high ratio of carbohydrates:protein. Where a MRP would have a 0.25-2:1 ratio of Carbohydrates:Protein a weight gainer would have in the order of between 3-5:1 ratios.

Thermogenic products

A thermogenic is a broad term for any supplement that the manufacturer claims will cause thermogenesis, resulting in increased body temperature, increased metabolic rate, and consequently an increased rate in the burning of body fat and weight loss. Until 2004 almost every product found in this supplement category comprised the "ECA stack": ephedrine, caffeine and aspirin. However, on February 6, 2004 the Food and Drug Administration (FDA) banned the sale of ephedra and its alkaloid, ephedrine, for use in weight loss formulas. Several manufacturers replaced the ephedra component of the "ECA" stack with bitter orange or citrus aurantium (containing synephrine) instead of the ephedrine.

See also

- ConsumerLab.com
- Examine.com
- Glycocarn
- Instant breakfast
- Protein bar
- Protein

Notes

- The effect of HMB on skeletal muscle damage has been assessed in studies using four different biomarkers of muscle damage or protein breakdown: serum creatine kinase, serum lactate dehydrogenase, urinary urea nitrogen, and urinary 3-methylhistidine.^{[37][40][41]} When exercise intensity and volume are sufficient to cause skeletal muscle damage, such as during long-distance running or progressive overload, HMB supplementation has been demonstrated to attenuate the rise in these biomarkers by 20–60%.^{[37][41]}

References

- McGinn, Dave (7 November 2010). "Are protein shakes the weight-loss magic bullet?". *Globe and Mail*. Retrieved 1 December 2010.
- Dalby A., Food in the Ancient World A-Z, Routledge (2008) pp. 203
- 85 *A.B.A. J.* 60 (1999), Hard to Swallow; Higgins, Michael
- Ravintolisissä paljon humpuukia (http://yle.fi/aihe/artikkeli/2012/10/17/ravintolisissa-paljon-humpuukia), Yle.fi 17.10.2012.
- "Are protein shakes the weight-loss magic bullet? - The Globe and Mail". *Theglobeandmail.com*. Retrieved December 11, 2015.
- "Body-building Products and Hidden Steroids: Enforcement Barriers". Food and Drug Administration.
- Spike in Harm to Liver Is Tied to Dietary Aids (http://www.nytimes.com/2013/12/22/us/spike-in-harm-to-liver-is-tied-to-dietary-aids.html?_r=0), The New York Times, December 21, 2013.
- Joseph, Jan; Parr, Maria (2015). "Synthetic Androgens as Designer Supplements". *Current Neuropharmacology*. **13** (1): 89–100. doi:10.2174/1570159X13666141210224756. PMC 4462045. PMID 26074745.
- Rocha, Tiago; Amaral, Joana S.; Oliveira, Maria Beatriz P.P. (2016). "Adulteration of Dietary Supplements by the Illegal Addition of Synthetic Drugs: A Review". *Comprehensive Reviews in Food Science and Food Safety*. **15**: 43. doi:10.1111/1541-4337.12173.
- "Marketplace: Some protein powders fail fitness test - Health - CBC News". *Cbc.ca*. Retrieved December 11, 2015.
- "Marketplace: Some protein powders fail fitness test - Health - CBC News". *Cbc.ca*. Retrieved December 14, 2015.
- Paul A. Offit, chief of the division of infectious diseases at the Children's Hospital of Philadelphia, and Sarah Erush, the clinical manager in the pharmacy department of the Children's Hospital of Philadelphia (December 14, 2013). "Skip the Supplements". *New York Times*.
- Tainted Body Building Products (http://www.fda.gov/Drugs/ResourcesForYou/Consumers/BuyingFDA, December 17, 2010.
- "Popular sports supplements contain meth-like compound". USA Today. October 25, 2013. "Cohen said researchers informed the FDA in May about finding the new chemical compound in Craze. The team found the compound — N,alpha-diethylphenylethylamine — has a structure similar to methamphetamine, a powerful, highly addictive, illegal stimulant drug. They believe the new compound is likely less potent than methamphetamine but greater than ephedrine."
- Sports supplement designer has history of risky products (http://www.usatoday.com/story/news/nation/2013/07/25/bodybuil-supplement-designer-matt-cahill-usa-today-investigation/2568815/), USA Today, September 27, 2013.
- Nutrition Working Group of the International Olympic Committee (2003). IOC Consensus Conference on Nutrition for Sport. Lausanne Missing or empty |title= (help); |contribution= ignored (help)
- Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients), 2005, 661 [1] (https://www.nap.edu/read/10490/chapter/12#661)
- Journal of Sports Sciences, 2004, 22, 65–79 Protein and amino acids for athletes [2] (http://www.uni.edu/dolgener/Advanced_Sport_Nutrition/protein_
- Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients), 2005, 589 [3] (https://www.nap.edu/read/10490/chapter/12)
- "IOC POWERADE NUTRITION WINTER - en_report_833.pdf" (PDF). *Olympic.org*. Retrieved December 15, 2015.

21. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients), 2005, 661-662 [4] (<https://www.nap.edu/read/10490/chapter/12#662>)
22. "Alert: Protein drinks. You don't need the extra protein or the heavy metals our tests found". *Consumer reports*. **75** (7): 24–7. 2010. PMID 20578336.
23. Tarnopolsky, MA; MacDougall, JD; Atkinson, SA (1988). "Influence of protein intake and training status on nitrogen balance and lean body mass". *Journal of applied physiology*. **64** (1): 187–93. PMID 3356636.
24. Lemon, PW (1995). "Do athletes need more dietary protein and amino acids?". *International journal of sport nutrition*. 5 Suppl: S39–61. PMID 7550257.
25. Wolfe, Robert R (2000). "Protein supplements and exercise". *The American Journal of Clinical Nutrition*. **72** (2 Suppl): 551S–7S. PMID 10919959.
26. Kerstetter, JE; O'Brien, KO; Insogna, KL (2003). "Dietary protein, calcium metabolism, and skeletal homeostasis revisited". *The American Journal of Clinical Nutrition*. **78** (3 Suppl): 584S–592S. PMID 12936953.
27. Kerstetter, JE; O'Brien, KO; Insogna, KL (2003). "Low protein intake: The impact on calcium and bone homeostasis in humans". *The Journal of Nutrition*. **133** (3): 855S–861S. PMID 12612169.
28. Dawson-Hughes, B; Harris, SS; Rasmussen, H; Song, L; Dallal, GE (2004). "Effect of dietary protein supplements on calcium excretion in healthy older men and women". *The Journal of Clinical Endocrinology and Metabolism*. **89** (3): 1169–73. doi:10.1210/jc.2003-031466. PMID 15001604.
29. Sizer FS, Piché LA, Whitney EN (2012). *Nutrition: Concepts and Controversies*. Cengage Learning. p. 407. ISBN 0-17-650258-0.
30. Chapman, D. J.; De-Felice, J.; Barber, J. (1983). "Growth Temperature Effects on Thylakoid Membrane Lipid and Protein Content of Pea Chloroplasts". *Plant Physiology*. **72** (1): 225–8. doi:10.1104/pp.72.1.225. PMC 1066200. PMID 16662966.
31. Becque, M. Daniel; Lochmann, John D.; Melrose, Donald R. (2000). "Effects of oral creatine supplementation on muscular strength and body composition". *Medicine & Science in Sports & Exercise*. **32** (3): 654–8. doi:10.1097/00005768-200003000-00016.
32. Birch, R.; Noble, D.; Greenhaff, P. L. (1994). "The influence of dietary creatine supplementation on performance during repeated bouts of maximal isokinetic cycling in man". *European Journal of Applied Physiology and Occupational Physiology*. **69** (3): 268–70. doi:10.1007/BF01094800.
33. Rae, C.; Digney, A. L.; McEwan, S. R.; Bates, T. C. (2003). "Oral creatine monohydrate supplementation improves brain performance: A double-blind, placebo-controlled, cross-over trial". *Proceedings of the Royal Society B*. **270** (1529): 2147–50. doi:10.1098/rspb.2003.2492. PMC 1691485. PMID 14561278.
34. Watanabe, Airi; Kato, Nobumasa; Kato, Tadafumi (2002). "Effects of creatine on mental fatigue and cerebral hemoglobin oxygenation". *Neuroscience Research*. **42** (4): 279–85. doi:10.1016/S0168-0102(02)00007-X. PMID 11985880.
35. Schwarzenegger, Arnold; Bill Dobbins (1998). *The New Encyclopedia of Modern Bodybuilding, 2nd ed.* New York: Simon & Schuster Paperbacks. pp. 764–5. ISBN 978-0-684-85721-3.
36. Green AL, Hultman E, Macdonald IA, Sewell DA, Greenhaff PL (November 1996). "Carbohydrate ingestion augments skeletal muscle creatine accumulation during creatine supplementation in humans". *Am. J. Physiol*. **271** (5 Pt 1): E821–6. PMID 8944667.
37. Momaya A, Fawal M, Estes R (April 2015). "Performance-enhancing substances in sports: a review of the literature". *Sports Med*. **45** (4): 517–531. doi:10.1007/s40279-015-0308-9. PMID 25663250. "Wilson et al. [91] demonstrated that when non-resistance trained males received HMB pre-exercise, the rise of lactate dehydrogenase (LDH) levels reduced, and HMB tended to decrease soreness. Knitter et al. [92] showed a decrease in LDH and creatine phosphokinase (CPK), a byproduct of muscle breakdown, by HMB after a prolonged run. ... The utility of HMB does seem to be affected by timing of intake prior to workouts and dosage [97]."
38. Wu H, Xia Y, Jiang J, Du H, Guo X, Liu X, Li C, Huang G, Niu K (September 2015). "Effect of beta-hydroxy-beta-methylbutyrate supplementation on muscle loss in older adults: a systematic review and meta-analysis". *Arch. Gerontol. Geriatr*. **61** (2): 168–175. doi:10.1016/j.archger.2015.06.020. PMID 26169182.
39. Briocche T, Pagano AF, Py G, Chopard A (April 2016). "Muscle wasting and aging: Experimental models, fatty infiltrations, and prevention". *Mol. Aspects Med*. doi:10.1016/j.mam.2016.04.006. PMID 27106402. "In conclusion, HMB treatment clearly appears to be a safe potent strategy against sarcopenia, and more generally against muscle wasting, because HMB improves muscle mass, muscle strength, and physical performance. It seems that HMB is able to act on three of the four major mechanisms involved in muscle deconditioning (protein turnover, apoptosis, and the regenerative process), whereas it is hypothesized to strongly affect the fourth (mitochondrial dynamics and functions). Moreover, HMB is cheap (~30–50 US dollars per month at 3 g per day) and may prevent osteopenia (Bruckbauer and Zemel, 2013; Tataru, 2009; Tataru et al., 2007, 2008, 2012) and decrease cardiovascular risks (Nissen et al., 2000). For all these reasons, HMB should be routinely used in muscle-wasting conditions especially in aged people. ... 3 g of CaHMB taken three times a day (1 g each time) is the optimal posology, which allows for continual bioavailability of HMB in the body (Wilson et al., 2013)."
40. Luckose F, Pandey MC, Radhakrishna K (2015). "Effects of amino acid derivatives on physical, mental, and physiological activities". *Crit. Rev. Food Sci. Nutr*. **55** (13): 1793–1807. doi:10.1080/10408398.2012.708368. PMID 24279396. "HMB, a derivative of leucine, prevents muscle damage and increases muscle strength by reducing exercise-induced proteolysis in muscles and also helps in increasing lean body mass. ... The meta analysis studies and the individual studies conducted support the use of HMB as an effective aid to increase body strength, body composition, and to prevent muscle damage during resistance training."
41. Wilson JM, Fitschen PJ, Campbell B, Wilson GJ, Zanchi N, Taylor L, Wilborn C, Kalman DS, Stout JR, Hoffman JR, Ziegenfuss TN, Lopez HL, Kreider RB, Smith-Ryan AE, Antonio J (February 2013). "International Society of Sports Nutrition Position Stand: beta-hydroxy-beta-methylbutyrate (HMB)". *J. Int. Soc. Sports. Nutr*. **10** (1): 6. doi:10.1186/1550-2783-10-6. PMC 3568064. PMID 23374455.
42. Brook MS, Wilkinson DJ, Phillips BE, Perez-Schindler J, Philp A, Smith K, Atherton PJ (January 2016). "Skeletal muscle homeostasis and plasticity in youth and ageing: impact of nutrition and exercise". *Acta Physiol (Oxf)*. **216** (1): 15–41. doi:10.1111/apha.12532. PMC 4843955. PMID 26010896.

External links

- Dietary Supplement Health and Education Act of 1994 (<http://www.fda.gov/food/dietarysupplements/default.htm>)

Retrieved from "https://en.wikipedia.org/w/index.php?title=Bodybuilding_supplement&oldid=757719076"

Categories: [Bodybuilding supplements](#) | [Instant foods and drinks](#)

- This page was last modified on 1 January 2017, at 09:47.
- Text is available under the Creative Commons Attribution-ShareAlike License; additional terms may apply. By using this site, you agree to the Terms of Use and Privacy Policy. Wikipedia® is a registered trademark of the Wikimedia Foundation, Inc., a non-profit organization.