

# Creatine Products Review

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## Creatine Products Review

**U**nderstandably, the multitude of creatine products currently on the market can be somewhat overwhelming, even for someone versed in the subject. Everyday new products appear on the shelf. Each new product bearing its own unique marketing twist solely designed to make it stand out from the rest of the competition. It is for this reason that one of the major goals of this products review is to help you make sense out of the formulations of some of the more popular creatine products. After reading this review, anyone should be able to easily interpret which ingredients are truly adding to the effectiveness of a given product, or merely included to inflate the price and to create a false sense of innovation.

The review is organized in order of increasing complexity. It commences with descriptions of pure forms of creatine monohydrate then progresses into more sophisticated formulations. Specific issues will be discussed in their order of appearance in the evolution of the products. It is thus a wise idea to start at the beginning and continue until you reach your particular product of interest, should it be present. Although this listing is in no way exhaustive, it is intended to be representative. The products covered are those that I'm most frequently asked about by my online visitors. There simply would not be enough time, space (in Gigabytes), or interest to cover all the products currently flooding the market. New product analyses will be forthcoming as the interest becomes apparent.

This guide also includes a brief price comparison of each product featured from different online vendors. Simply clicking on a price will automatically take you to the website of that vendor. That is, of course, if you are connected to the world-wide-web while reading this guide. *Obviously, the prices shown are subject to change without notice, especially where special limited-time offers have been posted.* [Updated versions](#) of this review will later reflect these changes.

Some of the products featured in this guide originate from (*what are in my opinion*) reputable creatine manufacturers. Nevertheless, despite their good reputations, some are not very transparent about the ingredients they include in their products. Proprietary secrets, I suppose. Moreover, the fact that some products change ingredients each time that a new version is released, further stymied my investigative efforts. It is, therefore, inevitable that holes in my knowledge about certain products should exist. Please accept my apologies in advance for any omissions, or errors, made.

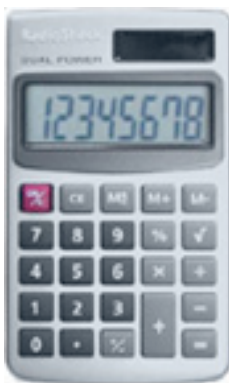
A more extensive version of this review can be available to those purchasing [Creatine: A practical guide](#). Also, please [contact me](#) with your impressions of this review. My hope is to make it the most worthwhile service possible and with your help, this goal may be one step closer to becoming a reality.

[Click here](#) to download a free update of this attenuated review.

Good health,  
Alfredo Franco-Obregón, PhD  
Author of [Creatine: A practical guide](#)  
[http://www.creatinemonohydrate.net/creatine\\_guide.html](http://www.creatinemonohydrate.net/creatine_guide.html)

November, 2006

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***Unsure of how much creatine to take?*** Use this calculator to help devise a creatine dose specifically designed to fit your age, sex and size.

Just click on the calculator or cut and paste the following link into your browser.

<http://www.creatinemonohydrate.net/calculator.html>

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## Creating a Creatine Product...

**T**he goal of any creatine product is, or should be, to maximize the absorption of creatine by muscle using the least amount of product possible. The successful creatine product will, therefore, maximize the physical benefits of creatine, while not stressing the body with an overload of creatine. In this respect, certain issues confront any aspiring creatine manufacturer: (1) creatine's low solubility in water; (2) muscle's limited capacity to transport creatine; and (3) how to effectively combine creatine with other nutritional supplements for the best effect. Therefore, in pursuit of the ultimate formulation, a manufacturer may include ingredients from one, two, or all, of following categories.

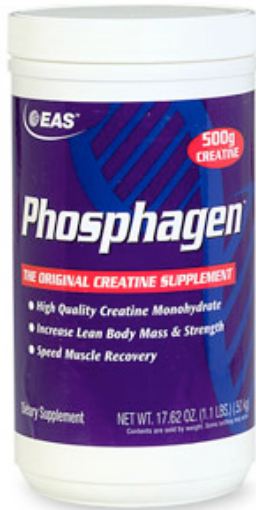
**Increasing solubility:** Creatine monohydrate is insoluble in water. This property of creatine causes it to collect within the large intestine, ultimately giving rise to gastrointestinal distress. In response to this complication, micronized, and effervescent forms of creatine were developed that are readily absorbed into the blood stream and, hence, have less of a tendency to collect within the intestinal compartment. Liquid forms of creatine are also now available that are reputed to be readily absorbed into the blood stream from the buccal mucosa (lining of mouth) and digestive tract. Some products also use the citrate form of creatine for its enhanced solubility in aqueous solutions. Nevertheless, although implementing these measures is a very good start, getting creatine into the blood stream is just the first step...

**Increasing absorption:** The second hurdle in creating an effective product is augmenting the amount of creatine that is absorbed by muscle. No simple task, given that creatine transport diminishes in the continual presence of creatine in the blood stream. Creatine is transported into muscle with the help of specific transporter molecules expressed on the muscle cell surface. These transporters harness the energy of sodium entering the cell to shuttle creatine across the muscle membrane. Therefore, any maneuver that increases sodium levels outside the cell, or extrudes sodium from the cell's interior, will augment creatine absorption. Developers of creatine products are thus well aware of the fact that one of insulin's principal effects is to create a favorable sodium gradient for the transport of creatine (and other amino acids) into the cell. In fact, enhancing insulin's effects is the basic strategy behind many creatine products. Agents that are known, or theorized, to potentiate the actions of insulin include chromium picolinate,  $\alpha$ -lipoic acid, D-pinitol, 4-hydroxyisoleucine, or the amino acids, taurine, L-arginine, and L-carnitine. Do not be surprised to find one, or more, of these agents in your particular creatine product. By far, the most potent releasers of insulin are glycemic sugars, in particular dextrose (glucose) and maltose (maltodextrin). Glycemic sugars have been unequivocally shown to evoke creatine transport by eliciting the transport capacities of insulin. It is very common to find glycemic sugars in creatine products.

**Complementing ingredients:** Thirdly, certain supplements may complement the benefits typically afforded by creatine, effectively extending it's anabolic potential. Agents sometimes added for this purpose include L-glutamine, L-carnitine, ribose, HMB, royal jelly, antioxidant vitamins, and B-vitamin complexes, to name just a few. Some of these agents have been clearly shown to possess anabolic, anti-catabolic, or metabolic properties, while others need to be investigated further. A [glossary](#) of the different nutritional supplements often combined with creatine is included at the end of this review. Here the benefits, side effects (if any) and safe doses of most of the listed nutritional supplements are provided.



## Phosphagen by EAS



### Ingredients per serving

Creatine monohydrate: 5 grams

**Manufacturer's Recommended Use:** Take one serving (5 grams) four times a day for the first 4-5 days of supplementation. This is known as the loading phase, since its purpose is to rapidly fill your stores. After loading, take one serving one to two times daily. This is known as the maintenance phase and is intended to "maintain" your stores full beyond the initial loading phase. Mix in juice or water.

**Product Description:** Formerly "simply creatine", this product was the original creatine supplement introduced by EAS back in 1993. More precisely, **Phosphagen** is "simply creatine *monohydrate*", which, in turn, is nothing more than a molecule of creatine accompanied by a molecule of water. Creatine monohydrate is, by

far, the most popular creatine supplement used in athletics. And, although citrate and phosphate salts of creatine also exist, they are much more expensive and have rarely been used in scientific studies examining athletic performance. Furthermore, since water is a much smaller molecule than either phosphate or citrate, these other forms of creatine contain less creatine per gram of powder. In other words, you would need to ingest greater amounts of the citrate and phosphate forms to get the same amount of creatine as in the monohydrate salt.

**Creatine Monohydrate:** When taking into account the 1:1 ratio of creatine to water, a 5 grams serving of creatine monohydrate contains nearly 4.4 grams of creatine. By contrast, a 5 grams serving of creatine citrate contains only 2 grams of creatine (~3 grams of citrate!), less than half the amount of creatine as creatine monohydrate! Just to complete the picture, 5 grams of creatine phosphate contains 3.1 grams of creatine. The vast majority of products that you will encounter (in this review and elsewhere) have creatine monohydrate as their main ingredient.

**Author's Evaluation:** For the quality and price, you can't beat this product. One container of **Phosphagen** contains enough creatine to last two complete cycles of supplementation. I'd further advise that you take this product with a source of carbohydrates (fruit juice or sports drink) and whey protein as explained in my [creatin guide](#). You can also greatly extend the effectiveness of this product (*affordably*) by including certain [B-vitamins](#) to your supplementing regimen.

**Quantity:** 500 grams

**Serving Size:** 5 grams (1.5 teaspoons)

**Number of Servings:** 100

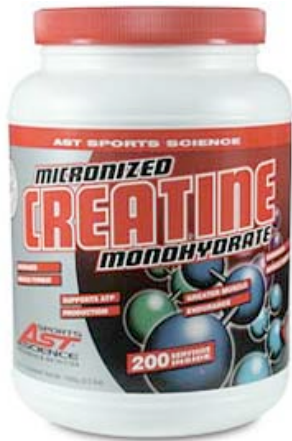
**Average Price:** \$14.21 (Generated from 4 online vendors)

**Price per serving:** \$0.14

[Comparison Shop](#)



## Micronized Creatine by AST



### Ingredients per serving

Micronized creatine monohydrate: 5 grams

**Manufacturer's Recommended Use:** Take 5 grams four times per day during the loading phase. During maintenance, take 5 grams twice per day. Prepare by mixing 1 heaping teaspoon (5 grams) into 6 to 8 ounces of water or juice. Drink immediately. Drink at least 8 to 10-8 ounce glasses of water each day while supplementing.

**Description:** Due to its high insolubility, creatine monohydrate has a tendency to clump into particles when placed in fluids. This issue is particularly problematic when the size of the particles impedes their escape from a compartment of the body. In these instances, the trapped creatine draws water into the body compartment where it is found. In scientific terms, creatine is said to impose an osmotic load. If creatine accumulates within the intestinal compartment, then diarrhea and gastrointestinal distress result from the increased absorption of water into the large intestine. This shortfall of creatine was the motivation for the development of the micronization procedure.

Micronization produces creatine particles that are 20-times smaller than normal. Due to their smaller size, micronized creatine particles are more readily absorbed into the blood stream and consequently, have less of a tendency to collect within the intestine. Miconization should thus circumvent the incidences of diarrhea and gastrointestinal distress that often accompany the use of ordinary creatine monohydrate powder. Micronized creatine particles also suspend more easily when mixing with your favorite juice or water, as is evidenced by the lesser amount of grit (creatine) remaining at the bottom of the glass.

**Author's Evaluation:** For the purest, this product is a very good choice, since it contains no additives and yet, is more apt to be absorbed into the blood stream. I suggest that you combine this product with fruit juice, [B-vitamins](#) and a good source of whey protein. Taking this product in this manner will create the optimal anabolic environment for muscle growth at an affordable price, especially after exercise. For those interested, my [creatine guide](#) clearly details how to combine creatine with other nutrients to best foster muscle growth.

**Quantity:** 1000 grams

**Serving Size:** 5 grams (1 teaspoon)

**Number of Servings:** 200

**Average Price:** \$37.17 (Generated from 5 online vendors)

**Price per serving:** \$0.19

**Comparison Shop**



## Creatine 6000-ES by MuscleTech



### Ingredients per serving

Micronized Creatine Monohydrate	6 grams
L-methionine, L-arginine, L-glycine	500 milligrams total

**Manufacturer's Recommended Use:** During loading, take 1 heaping teaspoon (6 grams), 5 times a day. During maintenance, take 1 heaping teaspoon, 1-3 times a day.

**Description:** This product contains a source of micronized creatine monohydrate to promote creatine absorption into the blood stream from the digestive tract. Also included are the three amino acids used by the body to synthesize creatine, methionine, arginine, and glycine. Supposedly, the rationale for this formulation is, on the

one hand, to immediately supply your muscles with more than enough creatine to meet their daily energetic requirements and, on the other hand, to provide the body with the full complement of amino acids to synthesize creatine - *if needed*.

On the surface, this may seem like a reasonable strategy. If you stop to think about it, however, this approach is somewhat redundant. I'll elaborate... Firstly, creatine synthesis is inhibited when the dietary intake of creatine is sufficient to meet the body's needs. The presence of creatine in the blood stream actually inhibits the expression of the enzymes that produce creatine from amino acids. Physiologically speaking, therefore, it simply does not make sense for the body to invest the energy to synthesize creatine, if it is already present in the body. Secondly, the amount of creatine recommended by this product is certainly more than sufficient to meet the body's daily needs. In light of these facts, therefore, adding these three amino acids to a creatine supplement, with the goal in mind of augmenting creatine synthesis, seems pointless. On the other hand, a role for L-arginine in promoting insulin-sensitivity does seem to be experimentally supported. Therefore, L-arginine should increase insulin-mediated uptake of creatine into the muscle cell.

**Author's Evaluation:** I have some reservations about this product. There is really no proof that the added amino acids make a difference in the effectiveness of this product. For the price, you would do better by purchasing a pure source of creatine and mixing it with fruit juice, whey protein and B-vitamins as explained in my [creatine guide](#).

**Quantity:** 510 grams

**Serving Size:** 6 grams (1 heaping teaspoon)

**Number of Servings:** 85

**Average Price:** \$26.65 (Generated from 6 online vendors)

**Price per serving:** \$0.31

**Comparison Shop**



## Micronized Creatine HSC by AST



### Ingredients per serving

DGC (dextrorotatory glucose crystals)	34 grams
Micronized creatine monohydrate	5 grams
Sodium	120 milligrams
Potassium	120 milligrams
Phosphate	120 milligrams
Taurine	100 milligrams

**Other Ingredients:** Magnesium sulfate, and essential B vitamin complexes (thiamin hydrochloride (B1), riboflavin (B2), niacinamide (B3), pantothenic acid (B5)), dipotassium & disodium phosphates. Also contains natural and artificial flavors.

**Manufacturer's Recommended Use:** For loading, drink 4 servings a day for 5 days. For maintenance, drink 1 to 2 servings daily. Mix in 6 to 8 ounces of cold water.

**Description:** **HSC** stands for "**H**yper-**S**aturation **C**reatine **C**omplex". This product contains more sodium than most other creatine products (120 milligrams). This fact is important, since creatine harnesses the energy of sodium entering the cell to be transported across the muscle membrane. This is roughly the same amount of sodium as contained in **Gatorade**® for driving glucose transport into the blood stream from the digestive tract via a similar transport mechanism. The B-vitamins (and magnesium) included in this product are important cofactors in cellular reactions producing energy. Furthermore, dipotassium and disodium phosphate provide phosphorous, which is essential for energy storage. Supplementing with B vitamins, magnesium and phosphorus should increase energy availability to working muscles. On another level, taurine is included to evoke the release of insulin, which should augment creatine absorption into muscle cells by eliciting the transport capabilities of insulin. Finally, **HSC** also contains **DGC** (**D**extrorotatory **G**lucose **C**rystals), a unique glucose crystal that is claimed to be a highly effective releaser of insulin and, likewise, should enhance creatine transport. Unfortunately, other than the summary given by **AST** about **DGCs**, I was unable to find any other information regarding this particular dextrose polymer, or its effects.

**Author's Evaluation:** The ingredients of this product are relatively harmless. This is a good choice for anyone looking for a creatine product containing only salts, amino acids, vitamins, and carbohydrates. That is, excluding "*more experimental*" nutritional supplements.

**Quantity:** 4 pounds (1814 grams)

**Serving Size:** 44 grams (1 scoop)

**Number of Servings:** 41

**Average Price:** \$30.88 (Generated from 5 online vendors)

**Price per serving:** \$0.75

**Comparison Shop**



## Betagen HP by EAS



### Ingredients per serving

Maltodextrin	5 grams
Creatine monohydrate	2 grams
HMB	1 gram
L-Glutamine	2 gram
Taurine	500 milligrams

**Other Ingredients:** B vitamins (thiamin (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine hydrochloride (B6), cyanocobalamin (B12) and folic acid) antioxidant vitamins (Vitamins A (beta-carotene), C & E) and calcium (from HMB). Also contains citric acid, sucralose, and natural and artificial flavors.

**Manufacturer's Recommended Use:** Add 1 scoop to 4 ounces (1.5 teaspoons) of water or juice, and stir/mix until dissolved. Use three servings daily.

**Description:** The distinguishing feature of **Betagen HP** is the inclusion of **HMB** in its list of ingredients. Recent evidence supports a role for **HMB** in muscle development following intense exercise. Glutamine is also included in the formulation and is particularly important in fighting the infections that might result from the stress of heavy exercise and to assist in muscle recovery. **Betagen** also includes essential antioxidant vitamins (A, C, E *and folic acid*) that are necessary to combat oxidative stress and offset the development of overtraining syndrome. The specific B vitamins used in this formulation should also help maintain a healthy methylation status (see [Issue 30](#) and [Issue 31](#) of the **Creatine Newsletter**). Finally, taurine is included in the formulation for its insulin-enhancing properties, among others. The objective of all the insulinotropic strategies thus far discussed is to recruit the transport capabilities of insulin following exercise, thus assuring the greatest transport of creatine and amino acids to maximally support muscle growth.

**Author's Evaluation:** There have been a couple of different incarnations of **Betagen** since its original introduction, so don't be surprised if you notice subtle variations in the ingredients. To my knowledge, **Betagen HP** is the most recent version. Personally, I've a fondness for **Betagen**; it is moderately priced and a sound formulation. I'd recommend it to nearly everyone. The physical implications of combining HMB and creatine are discussed in [Issue 24](#) and [Issue 25](#) of the **Creatine Newsletter**. Subscribe to the newsletter [here](#).

**Quantity:** 931 grams

**Serving Size:** 10.34 grams (2 level scoops)

**Number of Servings:** 90

**Average Price:** \$48.83 (Generated from 6 online vendors)

**Price per serving:** \$0.54

**Comparison Shop**



## Phosphagen XT by EAS



### Ingredients per serving

Three-stage carbohydrate blend	39 grams
Creatine monohydrate	10 grams
Taurine	1 gram
4-Hydroxyisoleucine	600 milligrams
Calcium	500 milligrams
Phosphorus	250 milligrams
Sodium	35 milligrams

**Other Ingredients:** Phosphorus derived from tricalcium and disodium phosphate salts. Also contains citric acid, silica and sucralose. Flavoring (natural and artificial) and coloring (FD&C Red #40) are added depending on flavor.

**Manufacturer’s Recommended Use:** Thoroughly mix one serving (62 grams) with 14-16 ounces of water. Consume immediately following workouts.

**Description:** Again, the basic rationale of this formulation is to recruit the transport abilities of insulin. As in many creatine products, taurine is included to assist in the insulin-mediated transport of creatine into the muscle cell. Uniquely, however, **Phosphagen XT** also includes 4-hydroxyisoleucine in the mix. Preliminary studies have shown that 4-hydroxyisoleucine enhances the ability of blood sugar to release insulin. **Phosphagen XT** also includes a “three-stage carbohydrate blend”, consisting of dextrose, maltose, and potato starch. Maltose and dextrose are both extremely glycemic and, hence, are included to spike insulin levels immediately after ingestion. This is done in hopes of getting a large amount of creatine into the muscle cell as rapidly as possible. Potato starch, which is less glycemic than maltose and dextrose, is included to keep your blood glucose levels from crashing after the initial surge in blood insulin. With this combination of carbohydrates, your muscles should be able to take full advantage of the anabolic effects of insulin for considerably longer.

**Author’s Evaluation:** I’m guessing that **XT** stands for **eXtra T**ransport? Although the formulation does seem to be geared towards this one objective, it is also the most expensive product featured in this review. I’d only recommend this product if price isn’t an issue. For the greatest anabolic effect accompany this product with whey protein and other essential nutrients as is clearly detailed in my [creatine guide](#).

**Quantity:** 1 pound 15 ounces or 878 grams

**Serving Size:** 62 grams (2 level scoops)

**Number of Servings:** 14

**Average Price:** \$31.01 (Generated from 6 online vendors)

**Price per serving:** \$2.21

**Comparison Shop**



## RiboForce HP (Effervescent Creatine by EAS)



### Ingredients per serving

Crystalline fructose	11 grams
Creatine citrate	5 grams
D-Ribose	3 grams
Taurine	1 gram

**Other Ingredients:** Citric acid, sodium bicarbonate, potassium bicarbonate, potassium phosphate monobasic, sodium phosphate monobasic, sucralose and cochineal. Natural and artificial flavors are also included as well as artificial coloring depending on the flavor.

**Manufacturer's Recommended Use:** Add the contents of one packet to 12 ounces of water, then mix. Use 1 serving daily.

**Description:** This product has two distinguishing features, the inclusion of ribose and the use of effervescence to assist creatine absorption. The cell uses ribose to produce **ATP**, the energy currency of life. Increasing ribose should increase cellular energy content.

**The Effervescent Reaction:** Essentially, an effervescent reaction requires the interaction of an acid with a bicarbonate (or carbonate) base. Mixing these components in water produces carbon dioxide gas and the salt of the acid. This particular product uses citric acid and sodium (and potassium) bicarbonate, that, when mixed in water, produces fizzy bubbles (carbon dioxide) and citrate salts (sodium citrate and potassium citrate). The principal function of the fizz is to buffer the pH of the suspension, which helps neutralize creatine's ionic charge. These ionic charges impede the passive absorption of creatine into the blood stream from the digestive tract. The inclusion of potassium phosphate monobasic and sodium phosphate monobasic also helps maintain an appropriate pH to facilitate creatine transport. This product also uses creatine citrate, which is reputed to possess greater bioavailability, and should experience no interference from the citrate salts formed during the effervescent reaction. Obviously, making an effervescent creatine is no simple task!

**Author's Evaluation:** This theory behind this formulation seems sound and well thought out. This is clearly one of the better effervescent creatine products on the market; definitely worth a try. This is also an excellent candidate to be taken with [this product](#).

**Quantity:** 825 grams

**Serving Size:** 27.5 grams (1 packet)

**Number of Servings:** 30

**Average Price:** \$51.43 (Generated from 8 online vendors)

**Price per serving:** \$1.71

**Comparison Shop**



## **Xtra Advantage® Creatine Serum® by MMUSA**



### **Ingredients per serving**

Creatine monohydrate

2.5 grams

**Other Ingredients:** Glucosamine, L-glutamine, L-taurine, L-carnitine, magnesium, zinc, calcium, vitamin B12, royal jelly, ginseng, honey, natural glycerine, natural flavor and distilled water.

**Manufacturer's Recommended Use:** A single 5 ml (1 teaspoon) serving may be taken by putting 5 small squeezes of the eyedropper directly under the tongue (each squeeze delivers 1 ml), or, if you prefer, a serving of creatine serum may be mixed with water.

**Description:** This is clearly the most visible line of liquid creatine products on the market. The development of a liquid form of creatine, while highly sought after in the industry, had eluded many manufacturers for quite some time. Although bypassing the drawbacks associated with creatine's poor solubility, a liquid formulation creates its own set of problems, which far outweigh any benefits it may provide. Namely, creatine monohydrate in solution degrades much more rapidly than the dry powder. This one issue, in fact, has been the nemesis of any would-be liquid creatine producer since the beginning.

**MMUSA** now claims to have a liquid formulation that is stable for up to two years. This line of creatine products goes under the registered name of **Creatine Serum®**. In particular, **Xtra advantage®** is one in the product line designed specifically for bodybuilders and resistance athletes. **Xtra advantage®** contains L-carnitine, which reputedly increases the efficiency of fat utilization during exercise. This product also contains ginseng and royal jelly, two natural remedies that have been used for centuries to treat fatigue. Glucosamine is also included and should help injured joints to regenerate following overuse or trauma.

**Author's Evaluation: Creatine Serum®** has recently been subject to some very harsh criticism due to the appearance of several recent studies that have seriously brought into question its efficacy. The results from these studies are critically analyzed in [Issue 27](#) and [Issue 28](#) of the **Creatine Newsletter**.

**Quantity:** 5.1 fluid ounces (115 milliliters)

**Serving Size:** 2.5 grams (5 milliliters)

**Number of Servings:** 30

**Average Price:** \$34.02 (Generated from 5 online vendors)

**Price per serving:** \$1.13

**Comparison Shop**



## Glossary of Nutritional Supplements, etc.

**Antioxidant vitamins:** Increased use of oxygen during exercise produces reactive oxygen species (ROS) that can damage cellular membranes and eventually lead to muscle cell death. This is a situation commonly referred to as **Oxidative Stress**. The body possesses a battalion of endogenous antioxidants that are normally able to neutralize ROS as soon as they are produced. During exercise, however, the quantity of ROS produced can overrun your natural antioxidant defenses. Under these circumstances, it may be advisable to supplement your diet with essential antioxidant vitamins. Vitamins A, C, and E are three very important antioxidant vitamins that should be included in the diet of every athlete. Beta-carotene is often given in place of vitamin A, since the body readily converts it to the vitamin. Of these three, I would certainly recommend supplementing your diet with vitamin E (d- $\alpha$ -tocopherol). Excellent natural sources of vitamin E include almonds, avocados, and olive oil. Doses of vitamin E typically recommended range from 100 to 1000 IU (international units) per day, which is equivalent to about 60 to 600 milligrams of Vitamin E. Natural sources of Vitamin C include citrus fruits, red peppers and tomatoes and typical doses range between 200 and 500 milligrams per day. Folic acid has also recently been shown to possess antioxidant properties (see next as well as [Issue 31](#) of the **Creatine Newsletter**).

**B Vitamins:** A family of water-soluble vitamin usually consisting of ten members. The B vitamins, although not related on a structural level, are grouped together for purely historical reasons; they were all originally isolated from the same sources, liver, and yeast. With the exception of B12, which is present only in meat and dairy foods, the others B vitamins are found in whole grain cereals, legumes, leafy green vegetables, and fruits. The body does not readily store the B vitamins, and when they are present in excess, are excreted from the body in the urine. They must, therefore, be constantly replenished via dietary means. The B vitamins are heat-labile, so cooking greatly reduces the amount of these vitamins present in foods. A deficiency of B vitamins is most crucial to cell that are actively dividing and metabolizing energy such as skin, blood cells, the digestive tract and the nervous system. The B vitamins are not toxic, although megadoses may cause symptoms.

Although having diverse functions, most of the B vitamins are involved with the production of energy (ATP) from carbohydrates and fats. The B vitamins generally function to assist the activity of enzymes that participate in energy production during cellular respiration. Hence, they are referred to as “cofactors”. Magnesium is another important cofactor used in these cellular energy reactions. The B vitamins are thiamine (B1), riboflavin (B2), nicotinic acid (niacin, B3), pantothenic acid (B5), pyridoxine (B6), folic acid (B9), cyanocobalamin (B12), choline, inositol and biotin. Finally, as **B2, B6, B12, choline** and **folic acid** are all involved in one-carbon metabolism (methionine metabolism), they will have broad ramifications for overall health status. [Issue 30](#) and [Issue 31](#) of the **Creatine Newsletter** explain the importance of this effect of folic acid and other essential B-vitamins on muscle anabolism.

**Carnitine:** Named for the Latin word for meat, or *carnis*, from where it was first isolated. Carnitine is responsible for the shuttling of long-chain fatty acids into the mitochondria for use as an energy source during cellular respiration. Since fatty acids are the principal fuel source during prolonged exercise, carnitine supplementation is often used as a weight-loss

measure. Nevertheless, despite compelling evidence supporting a role for carnitine in the oxidation of long-chain fatty acids, available research falls short of clearly demonstrating increases in lean muscle mass (in humans) following carnitine administration. On the other hand, a growing body of evidence is suggesting that carnitine assists in insulin signaling. Carnitine deficiencies are characterized by depressed energy levels, muscle weakness, and weight gain. Chest pain, muscle soreness, low blood pressure, and confusion are also associated with reduced levels of carnitine.

The body synthesizes carnitine from lysine and methionine (two essential amino acids) in the liver and kidneys, from where it is subsequently transported to skeletal muscle, heart, brain, and sperm. Interestingly, this pattern of synthesis and distribution is identical to that observed from creatine (see below). Vitamin C and iron are necessary for the efficient synthesis of carnitine by the body. The richest natural source of carnitine is red meat (especially lamb) and dairy products. Fish and poultry contain relatively lesser amounts of carnitine. Wheat, asparagus, avocados, peanut butter, and tempeh (fermented soybeans) are good vegetable sources of carnitine. Fruits and vegetables typically contain little, or no, carnitine. An average omnivorous diet contributes between 0.05 and 0.100 grams of carnitine each day.

Carnitine has also been used in the clinical treatment of chronic fatigue syndrome, heart disease, congestive heart failure, high cholesterol, alcohol-related liver disease, kidney disease (and hemodialysis), dementia, and Down's syndrome with varying degrees of success. Although carnitine use is relatively safe, high doses (greater than 5 grams per day) may cause diarrhea. Rare incidences of increased appetite, body odor, and rash have also been reported following carnitine use. Finally, the L-form of carnitine is advised, since the D-form may interfere with the ability of L-carnitine in performing its cellular duties. L-acetylcarnitine and L-propionylcarnitine are other common used forms of carnitine. Typical doses of carnitine used in the scientific literature range between 1-4 grams per day.

**Cochineal:** A red coloring agent extracted from the crushed body of the female cochineal insect (*Dactylopus coccus*). One pound of dye requires about 70,000 insects. The ancient Aztec Indians of Mexico were the first to use cochineal for the coloring of foods, fabric, and paint. The Spanish would later consider the dye the second most valuable commodity after gold and demanded it as tribute from the Aztecs. During the American-British revolutionary war, the British were "*redcoats*" because of cochineal!

The cochineal insect makes his home of the prickly pear cactus, also known as nopal. The nopal bears crimson fruit known as "tunas", or "cactus apples", from which the dye is derived. Today, this dye is used to give the deep red color to certain fruit juices, gelatins, candies, red applesauce, cherry coke, and shampoos. Berry and fruit punch flavored creatine supplements may use cochineal as a coloring agent.

The dye contains carminic acid, which protects the cochineal insect from most predators and, by the way, is an excellent ant-repellant. Not surprisingly, carminic acid has also causes allergic reactions in some people. The importance of cochineal skyrocketed, once again this century, in the food industry when certain synthetic red dyes were found to be potentially carcinogenic. Cochineal is not kosher, since Jewish dietary laws prohibit the inclusion of insects (or their parts) in foods. I suppose, it would also be contrary to vegan philosophy. Cochineal is also known as Carmine. Often mistaken for FD&C Red Dye #40 that is made from coal.

**Creatine Monohydrate:** The synthetic form of creatine most frequently used as a dietary supplement to enhance athletic performance. Natural sources of creatine include sources of meat and fish. Creatine is also synthesized by the body in the liver, kidney and, to a lesser degree, the pancreas from the amino acids arginine, glycine, and methionine.

Scientific studies have shown that creatine supplementation enhances athletic performance during explosive bouts of strenuous exercise. Creatine acts by increasing the availability of ATP to exercising muscles and by reducing muscle acidity, thereby offsetting muscle fatigue.

Creatine is something naturally contained in high quantities in muscle, brain, heart, and testes. Therefore, the potential problems with creatine supplementation do not have to do with its mere presence, but, rather, how much is present and for how long. Ingestion of a few grams a day of creatine monohydrate is relatively safe. Gastrointestinal distress has been reported when large doses (greater than 20 grams) are consumed each day. There is also some concern that creatine supplementation may unduly stress the kidneys when consumed in great quantities. More information about the possible side effects of creatine supplementation is found in my [creatine guide](#).

**Dextrose:** Another name for glucose. Dextrose is highly glycemic meaning that it is very effective at releasing insulin into the blood stream. Dextrose is, therefore, equally effective at augmenting creatine uptake by muscle cells.

**Ginseng:** The dried root of one of several species of perennial herb of the family *Araliaceae*. Asian ginseng has been used in traditional Chinese medicine for over 2,000 years. Closely related, American ginseng (*Panax quinquefolius*) and, more distantly related, Siberian (*Eleutherococcus senticosus*) ginseng also exist. The active ingredients in ginsengs are thought to be a group of agents collectively known as ginsenosides. Thirteen ginsenosides have, thus far, been identified. Of these, ginsenosides Rb1 and Rg1 have been closely studied. Other constituents of ginseng include panaxans, which may help lower blood sugar, and certain polysaccharides, which are thought to support immune function. The concentration of ginsenosides within a root increases with age. Ginseng roots of greater than one hundred years of age are, therefore, highly praised for their potency.

Ginseng is widely used to increase vitality, improve insulin-sensitivity, counter the effects of stress, combat cancer, and treat impotence. Ginseng may also exert neuroprotective effects. Nevertheless, the effects of ginseng on athletic performance are currently equivocal.

Ginseng is generally safe. In rare instances, however, ginseng has been found to cause insomnia and, hence, should not be mixed with caffeine. Persons with high blood pressure should probably abstain from using ginseng. Long-term use of ginseng has been shown in some women to alter menstrual cycles and cause breast tenderness.

**Glucosamine:** A relatively simple molecule composed of glucose and an amine group (nitrogen and two hydrogens). Glucosamine's principal function in the body is to stimulate the production of glycosaminoglycans, which are key structural components of the cartilage between joints. It also inhibits enzymes that degrade cartilage tissue, and blunts damage from certain exogenous chemicals.

Research has clearly shown that glucosamine, as glucosamine sulfate, helps rebuild arthritic and degenerating joints. The inability to produce sufficient amounts of glucosamine to regenerate damaged joint tissue may be a leading cause of osteoarthritis in later life, particularly after trauma and heavy training.

Supplementing with glucosamine sulfate is relatively safe. Nevertheless, glucosamine is derived from shellfish. Therefore, if you have an allergic reaction to shellfish, you should consult your doctor before taking glucosamine products. Glucosamine sulfate may also increase the risk of developing resistance to insulin. Diabetics should exercise extra care, checking their blood sugar regularly, while taking glucosamine products. Finally, ingesting large quantities of glucosamine may also lead to gastrointestinal complications, including nausea, diarrhea, indigestion, and heartburn. Glucosamine should be taken with meals to help avoid these problems.

**Glutamine:** Glutamine is, by far, the most abundant amino acid in the body and is involved in more metabolic processes than any other amino acid. Interestingly, overtraining severely depletes our glutamine levels increasing our susceptibility to illness. Glutamine is also a major fuel source for cells of the immune system, in particular cells known as lymphocytes, macrophages, and killer cells. In response to invading bacteria and viruses, these cell types rapidly increase in number to mount a counterattack. When glutamine levels are low, however, the ability of these immune cells to multiply and defend the body is greatly compromised. This explains why athletes who overtrain are more susceptible to throat infections and colds. Glutamine is also used for the production of glutathione, one of the body's chief antioxidants. In this respect, glutamine will diminish the negative consequences of oxidative stress (see **Antioxidant vitamins**) and offset the onset of overtraining syndrome. Glutamine is also a nitrogen source for a variety of important molecules of the body. For example, the nitrogen group of glutamine may be used in the synthesis of our genetic material, i.e., nucleic acids. Finally, evidence exists indicating that glutamine promotes protein synthesis in a variety of cell types because of its ability to enhance cell hydration. This is a process similar to muscle cell volumizing in response to creatine use.

**Glycemic Index:** A measure of the ease with which a food releases insulin into the blood stream. The most glycemic of foods are typically simple and processed carbohydrates. Since insulin assists with the transport of creatine into muscle cells, creatine supplements often include simple carbohydrates in their formulations to maximize muscle absorption. With reference to creatine transport, therefore, maltose (maltodextrin) and dextrose (glucose) are the best choices to accompany creatine, since they are highly glycemic and, consequently, will stimulate the greatest uptake of creatine. Fructose, on the other hand, is a poor choice, since it is only moderately glycemic and will evoke relatively little creatine uptake.

**4-Hydroxyisoleucine:** An amino acid extracted from fenugreek seeds (*Trigonella foenum-graecum*). 4-Hydroxyisoleucine potentiates the secretion of insulin from the pancreas (beta cells) in response to the presence of glucose in the blood stream. Importantly, this effect of 4-hydroxyisoleucine is mitigated when blood glucose levels diminish because of increased transport into the cell. 4-Hydroxyisoleucine thus avoids a strong drop in blood glucose levels, otherwise known as hypoglycemia, that is characteristic of other insulinotropic drugs used to treat type II diabetes. The glucose-dependency is thus an important feature of 4-hydroxyisoleucine. Although data is limited, typical doses of 4-hydroxyisoleucine used in scientific studies appear to be in the range of 0.3-1 grams per day.

**HMB (3-Hydroxy-3-MethylButyrate):** A metabolite of leucine that is naturally produced by the body in small quantities, around 0.2-0.4 grams per day. One of the major roles of HMB is to serve as a precursor for cholesterol. Cholesterol, in turn, is necessary for proper functioning of the cell membrane as well as for the production of our steroid hormones, both anabolic and catabolic. Physical stress interferes with the cell's ability to produce sufficient amount of HMB to support cholesterol synthesis. HMB thus reduces muscle membrane damage following strenuous exercise. There is also evidence that HMB reduces the rate of protein degradation, particularly following bouts of intense exercise. These attributes of HMB should, therefore, translate into greater gains in fat-free mass and strength during resistance training. Although the available evidence in support of HMB (or leucine) in increasing lean muscle mass is clearest in animal studies, preliminary data supports a similar role in humans. Natural sources of HMB include catfish, grapefruit, and alfalfa. Finally, HMB appears to be relatively side effect free. Most scientific studies have used HMB in the dose range of 1.5-3 grams per day.

**Insulin:** A hormone released by the pancreas in response to the presence of nutrients, particularly glucose, in the bloodstream. Insulin induces the cells of the body to take up glucose and amino acids from the blood stream to sustain cellular metabolism. The transport of creatine into muscle cells is also promoted by insulin; creatine is structurally related to amino acids. In this manner, insulin exerts a permissive effect over muscle anabolism, which is particularly potent after exercise when muscle is most sensitive to the effects of insulin and testosterone and growth hormone are present.

**Mitochondria:** Also known as the powerhouse of the cell, these organelles oxidize amino acids (proteins), fatty acids (fats) and glucose (principally carbohydrates) to a form of usable energy known as adenosine triphosphate (ATP).

**Phosphorus:** The cell converts elemental phosphorus into phosphate (phosphorus and four oxygen atoms). The presence of high-energy phosphates in the cell is synonymous with cellular energy content. Enzymatically attaching a phosphate group to either creatine or **Adenosine-DiPhosphate (ADP)** adds energy to these molecules. The newly energized molecules are then known as **phosphocreatine** and **Adenosine-TriPhosphate (ATP)**. This energy is later made available to the cell as needed.

**Ribose:** A pentose (side-sided) sugar used in the synthesis of **Adenosine TriPhosphate (ATP)**. In fact, ATP is nothing more than the union of ribose, adenosine, and phosphates. To form ATP, ribose is coupled at one end to a molecule of adenosine and at the other with three phosphate groups. Increased anaerobic metabolism, as during heavy exercise, degrades our existing ATP pools, which, in turn, increases the need for ribose. Available evidence seems to indicate that ribose supplementation increases intramuscular ATP concentration after episodes of intense exercise, although exercise performance is only minimally effected. The synthesis of ribose from glucose serves as the primary source of ribose, since only trace amounts are found in the diet.

**Royal Jelly:** A creamy white liquid secreted from the salivary glands of worker bees that is used to nourish young larvae and serves as the exclusive source of nourishment for the queen bee. The relative longevity and reproductive capacity of the queen bee have been attributed to her diet of royal jelly. The components of royal jelly include amino acids, in particular aspartic acid, vitamins A, C, D, E, as well as B vitamin complexes (thiamin, riboflavin,

pyridoxin, niacin, biotin, pantothenic acid, folic, and inositol), trace minerals as well as calcium, copper, iron, potassium, phosphorus, silicon, and sulfur, essential fatty acids, sugars, sterols, and acetylcholine, a neuronal transmitter. Royal jelly has been shown to cause allergic reactions in some persons.

**Sucralose:** An artificial sweetener also sold under the name of **Splenda**®. Sucralose is non-caloric and although derived from sucrose (table sugar), is 600-times sweeter. Sucralose, since the body does not readily metabolize it, does not alter blood glucose levels and, hence, is a sweetening option for diabetics. As far as artificial sweeteners go, sucralose appears to be one of the safest on the market. For example, available research indicates that sucralose is far safer than either aspartame or saccharin. Studies in animals have demonstrated some internal organ and gestational abnormalities after sucralose administration.

**Taurine:** Next to glutamine, taurine is the second most abundant amino acid in the body. Interestingly, taurine is not incorporated directly into muscle proteins, but instead resides within intramuscular amino acid pools in free form. The predominance of taurine within skeletal muscle reflects its importance for proper muscle functioning. Taurine possesses anti-catabolic properties and possibly promotes cell hydration. Cell hydration has been shown to stimulate protein synthesis. Taurine should thus promote muscle anabolism. There are also indications that taurine possesses antioxidant properties and might, thus, assist in recovery from heavy training. In animal studies, taurine has been shown to assist in insulin-mediated responses. On the other hand, an effect of taurine supplementation on insulin-resistance in humans is harder to demonstrate. Regardless, diabetics typically possess lower than normal taurine levels. Stress and exercise also deplete taurine levels in the body. Taurine supplementation might, hence, be justified under certain circumstances. Taurine is produced from the amino acids methionine and cysteine with the assistance of vitamin B6 (pyridoxine). The best natural sources of taurine are animal proteins; with the exception of seaweeds, plants contain little taurine. Taurine supplementation is without severe side effects and is relatively safe. Typical doses of taurine used in the scientific literature are within the range of 0.5-3 grams per day.

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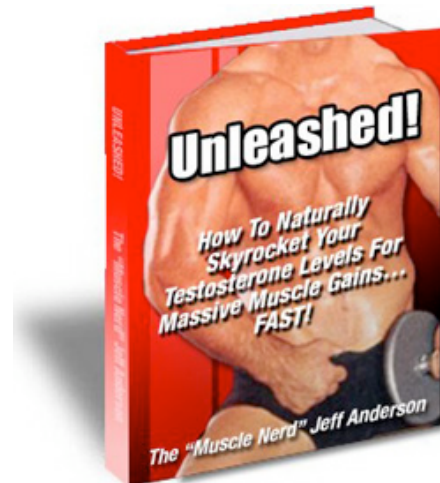
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