Special Updated 2005 Edition

CREATINE AND EXTREME MUSCLE MASS

The World's Most Authoritative Creatine User's Guide

* Over 50 Scientific Studies Reviewed
* Learn The Best Way To Take Creatine
* Know What Sports Creatine Works For
* Discover What Form of Creatine Works Best
* Plus, The Synergistic Ingredients To Increase The Effectiveness of Creatine

MAXIMUM MUSCLE - Guaranteed!

DANIEL GASTELU
Sports Nutrition Expert

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Read The Shocking Truth About What Creatine Can Really Do For You!

Plus, An Inside Look At The Newest Class of Super Anabolics
IMPORTANT NOTICE

This book is not intended for use as a substitute for consultation with a qualified medical practitioner. If you have symptoms of any illness, it is essential that you see your doctor without delay. You are unique, and your diagnosis and treatment must be individualized for you by your own doctor. This book provides exciting information about sports supplements and the ingredients they contain. But no book can replace the personalized care that you need. You are encouraged to work closely with your doctor and other health care professionals to achieve optimum health. The author or his agents will not accept responsibility for injury, loss, or damage occasioned to any person acting or refraining to act as a result of material contained in this book, whether or not such injury, loss, or damage is due in any way to any negligent act or omission, breach of duty, or default on the part of the author or his agents. The brand names included in this book are for illustration purposes and not intended to be an endorsement.
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Author’s Preface

This e-book is written to satisfy the needs of a diversified readership. It contains information for the athlete that can be easily understood, with convenient summary tables about sports Creatine supplementation is most useful for, and an overview of Creatine dosing regimens based on what the numerous research studies works best in light of current scientific evidence.

For the curious reader looking to learn more about the scientific aspects of Creatine, this information is included too, and contains a Creatine overview in Section 2 and a short course on muscle fiber anatomy, physiology, and bio-energetics in Section 3. For the scientist and scientific-minded athlete, a comprehensive review of the most current Creatine research studies is found in Section 4, along with the results of over 200 research studies spanning more then a decade of research, with a detailed summary of the most recent scientific studies.

This e-book will set the record straight about which form of Creatine works best, what dosing regimen has been prove to be effective, and the other sports nutrition ingredients Creatine can be used with for synergistic effects.

The Appendix includes examples of Creatine products, and a newest cutting-edge, super-anabolic product for maximum muscle building, strength boosting, improved athletic performance, and even fat burning and muscle definition enhancing effects; in a technological sports nutrition product breakthrough all-in-one formula.

The bonus section contains a special research update report about glucosamine and chondroitin sulfate. This report reveals the beneficial effects that these connective growth substances offer athletes, as well as all adults.

This e-book is part of an annual series that will be updated each year to bring you the most recent advancements in muscle building and sports nutrition science. You can also visit www.supplementfacts.com to sign up for our newsletter to keep updated on scientific advancements as they are happening, and to also checkout other e-books in this series.

The goal of this annual e-book series and the newsletter is to keep you years ahead of the competition, by providing publications based on the most recent information, research findings and expert advice. Most information in printed books is outdated the day it goes on sale.

Wishing You Become a Champion of Athletics and Life

Daniel Gastelu, M.S., MFS
Sports Nutrition Expert, Author & Publisher
International Sports Sciences Association (ISSA), Director of Nutritional Sciences
It seems that what should be the simplest and most straightforward of sports nutrition supplements, has become surrounded by a quagmire of misinformation, controversy, and in some instances, outright lies. Not by the scientific community, but from superficial information found in the media and even some ads for products.

The scientific community is onboard with recognizing the benefits athletes can experience from taking a creatine monohydrate supplement. In fact, creatine monohydrate has received more attention and has been subjected to more research studies than any other sports supplement being sold. Over 200 clinical studies have been conducted using creatine monohydrate in just over a decade. Not bad when you consider that the majority of the research was conducted at universities, without the mega-dollars from the pharmaceutical industry. By now, I think creatine monohydrate has as much research behind it as most of the billion dollar drugs.

**Why all of the nonsense?**

When you take a look at the science behind creatine monohydrate, there is little room for controversy. But somewhere along the way since creatine’s debut as a muscle building sports supplement, more controversy and confusion has arisen in the popular press, than has clarity of creatine’s purpose and proper use. From a sports scientist’s standpoint this is strange, because when you look at the trend in the scientific journals that have been reporting on the beneficial results of numerous research studies for over a decade, evidence is mounting to support the effectiveness of creatine monohydrate.

You may have noticed by now that I have been stating that creatine monohydrate has the scientific proof behind it. And it does. Sure, there are other forms of creatine, and I will be reviewing information about them for you later in this special report. However, even
though science concludes that creatine monohydrate is effective, most people want to
learn more about it, learn why it works, who it works best for, who it does not work for,
how much to take for best results, and why even think about creating other forms of
creatine in the first place.

So, when you read through this special report, you will discover it is part educational,
part scientific review and part use guide. I wanted it to suit the needs of many. In my
work I have found that there are some people who just want the at-a-glance use
information, and there others who want to learn and get insights about the research, how
the body works, and the about science of why creatine monohydrate works.

Some of the things you will learn about include:

➢ Why creatine works?
➢ What creatine really does in the body.
➢ Which athletes will benefit most from taking a creatine supplement.
➢ Do you need to take creatine forever?
➢ Does creatine works for men and women?
➢ Does creatine work for the young and old?
➢ Does creatine have other beneficial health effects?
➢ What is the science behind creatine?
➢ How do scientists take the studies and reach conclusions from them?
➢ Are there really any harmful side effects from taking a creatine monohydrate
  supplement?

The following section is an overview about creatine to help give you the big picture.
Then, due to the fact that creatine works best for certain types of athletes, with certain
types of muscle fiber development (primarily strength athletes), I included a section
about muscle fiber anatomy and physiology. If this subject matter is new to you, you may
have to read it a few times to catch on. The time spent will be worth it, because this
knowledge will benefit your training and nutrition program in other ways, in addition to
understanding what creatine works best for, and besides the muscle building benefits,
what research studies discovered creatine can help significantly improve athletic
performance. Yes, depending on the bio-energetic nature of your sport, you can improve your athletic performance starting in just a week or two of taking a creatine monohydrate supplement, and increasingly more benefits with continued creatine use.

For the extremely inquisitive reader, I included a mega-section that contains overviews of the actual scientific research studies, in an annotated bibliography format. So, in addition to a long list of references, I will take you through the highlights of these research studies, so you can get a glimpse in to how the scientific process works.

Finally, after reading through all of this information, you will find a section that contains information on what the numerous research studies support the best way to take creatine, and what sports creatine is good for improving athletic performance for, in addition to creatine’s well know effects in improving the rate of muscle growth and strength in association with a resistance training program.

You will also find an appendix which reviews some products, such as a top quality creatine, and also including an overview of a new type of combination product for muscle building and promoting performance improvements in strength athletes.
One of the best kept secrets in the sports nutrition industry is research grade creatine monohydrate; the highest quality of creatine used in research studies. The results of the research studies spanning over a decade continue to substantiate that research grade creatine works to help increase strength and muscle size at a faster rate. So one of the important points to getting results from taking creatine monohydrate is to get a product that meets research grade quality, meaning it is full potency, soluble, purified, and free from impurities (more on this will be reviewed in Section 5).

What about the magazine ads?
Each month after I read through the fitness and bodybuilding magazines, I find many of the ads for sports nutrition products perplexing, some of them outright fantasy. These days more then ever the market place has become a new-ingredient horse-race; you know, products with new and different combinations of ingredients making “I’m better” claims. Tragically, I see too many people, too often, getting diverted away from what scientific studies prove work best, to get you to try some new hype-of-the-month product instead. Getting results in bodybuilding and sports performance is about doing what works best, and sticking to it – perseverance. Sure, you want to be open-minded and test new approaches and products. But, you do not want to stop doing what works best at the sake of trying something new.

The number one question people ask me at seminars is how do you know what works and what does not? Second question is; what should I take?

Well, taking products with research proven ingredients, the ones with scientific studies backing their claims, is a good starting point. Now, I don’t mean that ingredients without comprehensive scientific studies do not work. I have worked on the cutting edge of
science my entire career, formulating and inventing products based on biochemical and physiological premises, as well as through testing and evaluation with all sorts of research. Including gathering information from people like you, pumping iron day in and day out to get big and strong, and keep good notes on how your bodies respond to new nutrition products. But, when I have to make a final decision about an ingredient, the ones that have the most human clinical studies usually win the selection race, with an occasional exception. Which leads me to the creatine story, keeping in mind that no one ingredient will do it all for you. In fact my list of efficacious sports nutrition ingredients keeps getting longer, and has filled entire books writing about them. In fact in, early in 2005 I will be publishing a special report about the top muscle building ingredients.

What about creatine?

From reading through the magazine ads I get the impression that the marketers of some of the newer, unproven products, like to take a stab at creatine’s time-tested and research proven reputation, to make their products appear better then they really are. As part of my work, when I read through these ads and product related books, I look-up the scientific references and read through the studies. However, I’m continually disgusted from doing this, because most of the time all of the references used by these marketers (not scientists) offer no proof that their product works; I guess they think people won’t take the time to check on this. The references usually are just phantom references included in the advertisements to impress the non-scientist reader.

When comparing this non-science to the dozens and dozens of good clinical studies conducted using creatine monohydrate, it turns out that creatine monohydrate remains one of the best strength and muscle building supplements you can purchase, assuming you are getting a quality product; note that a poor quality creatine products is a main reason why people don’t always experience the results that they should. As discussed below, research grade creatine is best. When you get a high quality sports nutrition product, you will get results. Too often however, companies create product with the appearance of being scientific and high quality, but are actually over priced and low quality. This is tragic, as the scientific research does indeed conclude that there are many
ingredients that will significantly improve your muscle building, strength building, and sports performance, in addition to promoting good health. So hopefully, this special report series will help empower you with the knowledge you need to determine what is best to achieve your specific goals.

To underscore this point about the proven effectiveness of creatine monohydrate, recently a team of independent scientists, headed by Ira Wolinsky, Ph.D., of the University of Houston, and Judy Driskell, Ph.D., R.D., of the University of Nebraska, put creatine monohydrate on the top of their “What Works for Strength and Muscle Mass” sports supplement list (Note that creatine has been on the top of my list for over 2 decades).

Creatine monohydrate made the Class “A” rating of these prominent researchers, along with some of the other bodybuilding essentials I will be reviewing in other special reports. This distinguished group of scientists who conducted the massive research review on creatine included Richard B. Kreider, Ph.D., who is a leading creatine researcher and supporter of using creatine as an ergogenic aid for sports performance and muscle building. (See Section 4 for a comprehensive review of the creatine research.)

These and other top sports scientists reviewed the creatine research and concluded the following about the effectiveness of creatine monohydrate:

- Promotes greater gains in increasing FFM (Fat Free Mass, which includes muscle mass).
- Increases muscle fiber size; hypertrophy.
- Increases muscle mass.
- Increases myosin.
- Improves maximal strength.
- Improves maximal power.
- Improves single-effort sprint performance.
- Improves worked performed during repetitive sprint performance.
- Improving performance during exercise of high to maximal intensity.

The combined results of the research studies prove that by taking creatine monohydrate you can get bigger, stronger muscles, better performing muscles, faster. Theses studies
reveal that creatine users consistently experience greater gains and improvements over the people who were not taking creatine in the studies. This means that creatine has been scientifically proven to produce statistically significant results, over and over again.

**Why Does Creatine Work?**

Improving muscle bioenergetics is one of the main ways creatine works, which I will elaborate on a bit here, and more in Section 3. One thing that occurs in your muscles from engaging in strength sports and resistance training is that you stimulate your type II muscle fibers to grow. The type II muscle fibers are the ones that can get big in size and generate fast, strong muscle contractions; they can contract very fast to generate tremendous power, when compared to slow-twitch muscle fibers which contract a slower rate of speed. For example, a 100 meter sprinter has big muscles to blast off of the starting line and run as fast as possible for a short distance. This takes big large, well conditioned fast-twitch muscles. Compare this to the marathon runner, who is faster then most people, but runs half as fast as the sprinter, but can do it for much longer. This is because marathon runners have well conditioned their type I, slow-twitch muscle fibers, with very little type II muscle fiber development. Type I muscle fibers contract slower when compared to Type II muscle fibers, they also have the ability to keep contracting for longer periods of time, at this lower level of intensity.

But, there is more to this story to understand why and how creatine fits in to the big-strong muscle picture. There are at least two kinds of Type II muscle fibers, Type IIa and Type IIb. Type IIa muscle fibers are also called fast-twitch oxidative glycolytic, FOG for short. At this point you may be detecting a trend in muscle fiber terminology. Exercise physiologists have classified these muscle fibers based on their ability to generate energy and muscle tissue contraction characteristics. Simply put, Type IIa muscle fibers have the ability to generate muscle contractions, which results in strength output over a certain period of time. The glycolytic and oxidative capacity of the Type IIa muscle cells can help produce energy to keep these strong, but not strongest, muscle contractions going for a sustained period of time. Glycolytic refers to the splitting of glucose in the muscle fiber to create energy. Fast-twitch muscle fibers are able to split glucose very rapidly to help
regenerate ATP quickly to sustain strong muscle contractions. Fast-twitch muscle fibers also contain high amounts of creatine and the high energy molecule phosphocreatine (PCr), also referred to as creatine phosphate (CP); note that the scientific community periodically changes terminology. Historically, scientists used the term creatine phosphate, but more recently they started to use phosphocreatine.

Now, Type IIb muscle fibers, called fast-twitch glycolytic (FG), are where creatine supplements have a major benefit. Type IIb muscle fibers are very large and they store plenty of ATP and PCr in their cellular fluid. This immediate chemical energy reservoir can be used to generate a tremendous muscle contraction of maximum effort energy for a few seconds, then as the reservoir of ATP & PCr gets depleted, the ability of the Type IIb muscles to generated maximum effort is reduced. The muscle fiber then has to make new ATP from primarily glucose, which takes time, and fatigue eventually sets in. Type IIa, fast-twitch oxidative glycolytic muscle fibers also benefit from creatine supplementation.

So, for maximum, explosive muscle contractions you need two things, well developed Type IIa and IIb muscle fibers (which takes time and smart effort), and muscle fibers that are loaded up with a large supply of ready to use ATP and PCr. It is during milli-seconds of all-out effort when the PCr (phosphocreatine) is used to make more ATP as fast as possible to keep the maximum effort going. However, eventually this immediate powerhouse of energy gets depleted, and the muscle’s capacity to sustain all-out effort is reduced. Taking creatine supplements results in loading up your all of you muscle fibers, in particular the Type IIb muscle fibers with phosphocreatine. This creatine loading gives your muscles ability to work harder and store more strength/power generating PCr. The net result is to stimulate faster gains in strength and muscle mass.

This is why creatine is best for strength and bodybuilding athletes, in order to promote Type II muscle fiber strength and size development progress. As you develop larger and better conditioned Type II muscle fibers, the benefits of taking a creatine monohydrate supplement will become even more important. It is this specific muscle development from progressive strength training and strength nutrition that needs to be customized to
best accomplish your muscle fiber development goals. In addition to creatine, there are other supplements that can also maximize and improve this process, in different ways.

Creatine supplementation is an example of good applied sports nutrition science. As an aside, during the 1980’s is when I started experimenting with creatine. I encountered the research on creatine when I was working in my United Kingdom branch office on some product development and marketing projects. I was able to secure some of the early produced research grade creatine that was available in Europe; when it was very, very expensive; too expensive to bring to market back then. I can tell you this for sure, when you take authentic research grade creatine you will experience greater gains in strength and lean body mass, when compared to most retail brand creatine. Depending on your level of training and experience, you can actually start feeling the benefits of research grade creatine the very first day, including better quality workouts and faster recovery. Improvements in muscle size and hardness are seen within a few days.

**Is Creatine Safe?**

YES, according to the most recent research reports. Based on the creatine research reviews mentioned above, the team of independent experts concluded that creatine is indeed safe. One of the most recent studies to demonstrate the safety of creatine was conducted over a 21 month period of time. In this study, conducted by Dr. Kreider and coworkers, they examined the long-term effects of Division IA football players taking an average of 5 g per day. The researchers concluded that long-term creatine supplementation did not appear to adversely affect the measures of health status in the creatine taking athletes, when compared to athletes who did not take creatine.

Furthermore additional benefits were revealed from this landmark long-term creatine study. According to Dr. Kreider and coworkers, when compared to the group of football players who did not take creatine, the football players who took creatine actually had fewer episodes of cramping, dehydration, muscle tightness, muscle pulls and strains, non-contact joint injuries, contact injuries, illness, number of missed practices due to injury, players lost for the season, and total injuries or missed practices. Therefore, this research indicates that creatine supplementation during athletic training and competition may
actually help reduce athletic injuries and adverse effects of athletic training. You can read more about this is in Section 5.

**Who Does Creatine Work For?**
Creatine monohydrate works for strength sport athletes and anyone who is resistance training to increase muscle mass and strength. Creatine works best for bodybuilding, weight lifting, power lifting and other competition strength sports, such as boxing, wrestling, martial arts, football, baseball, track and field strength/sprint events, other sprint related sports, including sprint swimming and soccer; Section 4 has a nice summary chart about this.

**If Creatine is Made by the Body, Why Take a Creatine Supplement?**
Creatine is manufactured in the body. Creatine is manufactured in the body from the amino acids arginine and glycine. These amino acids react to form a compound called guanidinoacetate, which gets turned in to creatine when it receives a methyl group from S-adenosylmethionine (SAMe). Also, ornithine is produced via this biochemical pathway. Creatine is also chemically known as: \(N\)-(Aminoiminomethyl)-\(N\)-methylglycine; \(N\)-amidinosarcosine; \(N\)-methyl-\(N\)-guanylglycine; and methylglycocyamine. At room temperature about 1 gram of creatine can dissolve in 75 milliliters, and as the temperature of the liquid is increased more creatine can be dissolved per volume of water.

Creatine is present in food (mostly from meat and fish) and available in supplemental form as creatine monohydrate. To body produces creatine primarily in the liver, this creatine then enters the blood stream, and is delivered throughout the body for use by muscles and other parts of the body. However, the research has determined that the body does not make enough creatine for optimum muscle performance; the body only makes about 1 to 3 grams of creatine per day. In fact, dietary creatine has always been an important source of supplemental creatine. Throughout history, strength athletes are legendary for consuming large amounts of meat. Well, meat also contains creatine. Eat more meat, and increase your intake of creatine. In modern times however, the practice of
cooking actually reduces the amount of creatine in meat; the heating converts some of the creatine to its breakdown product called creatinine. There is about 5 grams of creatine in 2.2 pounds of raw meat. So it is not very practical to rely upon dietary sources of creatine for reliably increasing the body’s creatine levels. At some point, a scientist probably thought; let’s see what happens when creatine supplements are ingested. The observations were that the total muscle content of creatine is increased, and phosphocreatine content was also increased.

So, creatine monohydrate is consumed to increase the body's stores of creatine and phosphocreatine. PCr is produced in the body by the combination of creatine and phosphate. In the body, PCr is stored in muscle tissue along with ATP. Together, PCr and ATP store the chemical energy of the body. The more energy they store, the better the muscles can perform in short-term maximum-strength events.
In this section I will take you through a short course in the science of weight training (resistance training) as it relates to muscle fiber development and bio-energetics. Familiarizing yourself with some of these terms and concepts will help provide an understanding of the link between resistance training, nutrition, and muscle fiber development.

I also want you to know some of the basic muscle physiology and biomechanics concepts, and the underlying reasons of how and why certain types of exercise will condition your body (muscles) in different ways. I will also explain you how creatine fits in to the muscle fiber picture, and how it works at the biochemical level of muscle function.

Confusion Abounds

Puzzlement about resistance training is still too common despite the advancements in resistance training science. It is more common to see people who are training ineffectively with weight lifting equipment, then to see people who are training correctly for specific strength and muscle building goals.

There are a few reasons for this. First, it’s human nature to want to do it yourself. So, armed with a little bit of knowledge, most people try to copy the experts and make up their own weight training program. In most cases these programs are not based on science or proven principles, or might not be suitable for your specific goal. I am not suggesting that you should not or could not customize your own weight training routine. By all means do so, but do your homework to make sure that you are following a program that is scientifically based, and both safe and effective to get the best results for your exercise effort and level of fitness. For example, following a resistance training program that
bodybuilders follow may get you bigger muscles, but might not get you the specific type of strength development you need to be better at your sport.

Another common mistake is that people try all sorts of crazy exercise variations, which in most cases put them at risk and leads to more exercise related injuries. They put themselves in extreme positions, attempting to shock or “isolate” the muscles in contorted ways. Don’t do this. In the end, a contorted weight training program is counterproductive and will lead to injury, and yield inefficient results. Stick to the basic resistance training exercises that are proven to work the muscle groups most effectively.

You may have asked yourself, why are there so many different weight training programs published in books and magazines? Perhaps it is because there are so many different types of machines, free weights and exercise program possibilities. Some programs are better than others. The good ones are based on solid exercise science. They offer clarity for the reader to help them achieve their personal goals. As you get more advanced in your training, you will be ready to add some new exercises so reading how others have achieved their performance-fitness goals in your sport may help you to stay on target, or enable you to discover something new to try. In addition, learning about the scientific insights from research studies is also very important.

When you take a close look at the exercises, the repetitions, and sets, there is an underlying similarity among effective weight training methods. In other words, most of the best athletes are training in a similar way, the scientific way. The key to effective resistance training is to follow the best routines that will help you achieve your specific goals, within the least amount of time. Keep mind that professional strength athletes use the same resistance training equipment as everyone else. Everybody follows the same principles of exercising different muscle groups using repetitions and sets. Different body parts may be trained the same days or on different days. Resistance training sessions are followed by periods of rest for those muscles exercised, which is needed to give the muscles you exercised time to recover, and grow. You may be wondering if resistance training is so standardized, then do people get such varying results.
When you compare the bodybuilders of past and present, or any group of strength athletes, it is interesting to note that these champions followed scientific resistance training programs “of the day” to build their massive physiques and super-human strength. Modern day resistance trainers on average are much bigger and stronger than their predecessors. Then why are there such differences in the size of their physiques and strength?

Some of the extra gains you see in today’s strength athletes stem from a new understanding of muscle anatomy and physiology, plus better nutrition science and sports nutrition products. We have made huge advancements in sports supplement technology, and have refined the strength and bodybuilding diet composition.

What you may find surprising is that there have been only a few advancements concerning the weight training equipment used by professional strength athletes. Free weights are still the primary instrument of choice for most of their exercises. They offer the best stimulus for muscle growth, providing a full range of motion, and usually, other muscles in the body are recruited for stability. However, research also indicates that combining free weight exercises, with exercises performed on machines is also beneficial. Machines offer convenience, especially when having to select a workload to exercise with, and provide a means to accomplish some exercises not otherwise possible with free weights. Resistance training machines also provide additional safety for some exercises. Ultimately, the resistance training exercises you use will reflect a balance of what best suits your goals, and what is available to you.

**Specific Training Yields Specific Results – Keep Your Goals in Mind**

Today championship bodybuilders can develop massive muscles using a more diversified scientific weight training program -- one that’s not necessarily longer, or harder, but smarter. This is due in part to a new understanding of anatomy and physiology and how growth occurs at the microscopic and biochemical level.
With this new knowledge, resistance training programs for other athletes can be designed for stimulating the different types of muscle cells, called muscle fibers, that make up your muscles. If you want a strong, lean, slim muscular body, or a massive, lean muscular body, the secret is in how you train your muscle fibers.

**Muscle Fibers**

You may find it interesting to know that your muscles are composed of different muscle fiber types, which in turn are programmed to respond differently depending on the type of exercise, frequency of exercise, workload/intensity, and duration of sets and exercise sessions.

One type of muscle fiber is called *fast-twitch*, and it has the potential to significantly increase in size and strength. Fast-twitch muscle fibers can generate explosive power, so whether it’s lifting a heavy load, leaping out of the way to avoid getting hit by a car, doing heavy physical work, or being your best in strength sports, your body will do it better, if you develop more fast-twitch muscle fibers.

### Muscle Fiber Types Summary

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<tr>
<th>Type I</th>
<th>Muscle Fibers, also called Slow-Twitch or Slow Oxidative (SO)</th>
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<td>Type I muscle fibers have a high oxidative metabolism capacity. They are highly fatigue resistant, with little capacity for exercise induced hypertrophy, and highly resistance to exercise induced structural damage. They are best conditioned using high repetition training with lighter weights and slow continuous tension movements. They will increase in size with weight training, but not as much as fast twitch muscle fibers. With progressive long duration training, slow twitch muscle fibers develop higher density of mitochondria, which increases their ability to produce energy from fatty acids and also glucose. They have a small diameter, with high capillary density and low glycogen content, when compared to fast twitch muscle fibers. Another major difference between type I and type II muscle fibers is that type I muscle fibers have larger myoglobin content. Myoglobin stores ready to use oxygen in the muscle fibers. Type I muscle fibers are the muscle fibers that get fully developed by long distance athletes. In general glucose and free fatty acids are the major fuel sources during long distance type activities that use predominantly type I muscle fibers.</td>
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<tr>
<th>Type IIa</th>
<th>Muscle Fibers, also called Fast-Twitch Oxidative-Glycolytic or Fast Oxidative Glycolytic (FOG)</th>
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<tbody>
<tr>
<td>Type IIa muscle fibers have a balance of oxidative-glycolytic metabolism capacity. They are moderately fatigue resistant, the have a good capacity for exercise induced hypertrophy (increase in the size of the</td>
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muscle fiber), and moderate resistance to exercise induced structural damage. Development of Type IIa muscle fibers is important for sustained, strength stamina. They respond best to medium repetition training using moderate weight and fast concentric movements, but slower eccentric movements. They are medium diameter, with intermediate capillary density, and intermediate glycogen content.

**Type IIb Muscle Fibers, also called Fast-Twitch Glycolytic or Fast Glycolytic (FG)**

Type IIb muscle fibers have high capacity for glycolytic metabolism, low oxidative capacity, and are highly susceptible to fatigue. They can be trained to store a ready to use supply of immediate energy in the form of ATP and CP. They have great capacity for exercise induced hypertrophy and susceptibility to exercise induced damage. Well developed type IIb muscle fibers have the capacity to generate explosive strength and power. They respond best to high intensity, explosive concentric movements using heavier weights, and a slow eccentric movement. When fully developed they have the largest diameter, high glycogen content, and low capillary density.

In general, creatine phosphate is the major source of energy for the first several seconds of high intensity activities, and also glucose metabolized via anaerobic glycolysis. Medium intensity and medium duration physical activity starts to depend more on aerobic energy producing pathways. Muscle glycogen is also depleted at a faster rate during high intensity training and athletics.

Note: the high energy storage / producing molecules ATP and CP are collectively referred to as phosphagens.

Another type of muscle fiber is called slow-twitch muscle fiber. Slow-twitch muscle fibers contract more slowly than fast-twitch muscle fibers do. Genetically, some people have more slow-twitch muscle fibers, while others have more fast-twitch muscle fibers.

In the trained individual slow-twitch muscle fibers have the capacity to perform work for a long period of time, with light workloads.

One way long distance exercises develop your slow-twitch muscle fibers by increasing the number of fat burning machinery in the cell, called mitochondria. Distance exercise also stimulates your body to make more blood vessels in your muscles to deliver oxygen and nutrients, and remove waste products at a higher rate. Sports such as long distance running, swimming, cycling, and walking condition slow-twitch muscle fibers, and so they are called aerobic exercises, or oxidative. The reason for this is that plenty of oxygen is needed for the slow-twitch muscle fiber cells to make energy from fats and carbohydrates, to fuel the steady pace muscle contractions, performed over time. In fact, the longer you exercise, and the better conditioned your slow-twitch muscle fibers will be, and the more fat your body will use for energy both during exercise and during rest.
From a strength and bodybuilding development standpoint, this low intensity, long duration exercise, provides certain fitness benefits, but does not build-up much muscle mass, or strength. In fact, it can have the opposite effects. To illustrate this, think of how a marathon runner is built when compared to a sprinter. They both run fast, but the marathon runner is conditioned to run as fast as possible for a long period of time – usually about a maximum of 12.5 miles per hour. The marathon runner has well developed slow-twitch muscle fibers, but underdeveloped fast-twitch muscle fibers. Some long distance runners actually develop bodies that make them look undernourished.

Sprinters on the other hand have trained their bodies to move as fast as possible over a very short distance -- 100 meters under ten seconds, for a maximum speed of about 22.5 miles per hour. This takes explosive muscle power, and a higher output of energy per second. To develop the capacity to do this, the sprinter needs to build up fast-twitch muscle fibers, which have the capacity to get really big, and generate explosive muscle contractions, for a short period of time before fatigue sets in. Visually sprinters are more muscular and shapely when compared to long distance athletes. And while athletes with highly developed fast-twitch muscle fibers mostly draw upon carbohydrates for energy, they are still able to maintain a low percentage of body fat because these larger muscles need more total calories per day for energy. Sprinters and other strength athletes have the timeless classic body of champions depicted in early Greek and Roman art -- the body type that comes from high intensity resistance training.

The point of this excursion into anatomy and physiology is to show you that your body has the ability to respond and develop differently depending on the type of exercise, frequency of exercise, intensity of exercise and duration of exercise. For the sake of this overview, heavy intensity resistance or weight training means using heavy workloads (weights, resistance), and expending a lot of energy in a short period of time. When you exercise at heavy intensity, your duration will be limited because muscle fatigue occurs quickly from this type of physical exertion. Light intensity weight or resistance training means using light workloads that can be performed for more repetitions, and longer periods of time. Medium intensity weight or resistance training means using weights
somewhere in between heavy and light, with the number of repetitions per set also in the middle range. When following a weight training program using a variety of heavy intensity, medium intensity, and light intensity work loads, you will actually be stimulating increases in strength and muscle growth in all of your muscle fibers.

**Where Creatine Fits In**

Due to the fact that your muscles are composed of both fast-twitch and slow-twitch muscle fibers, this leads to some dynamic muscle building possibilities. But the story gets even more interesting, because there are two primary types of fast-twitch fibers in your muscles. One type, called type IIb (or fast-twitch glycolytic), can be trained to grow to massive proportions and has the ability to store more immediate energy in its cellular liquid, that can then be used to fuel extremely powerful muscle contractions. This immediate energy is used up quickly under extremely heavy workloads, and fatigue sets in within a few seconds when exerting maximum effort. The other type of fast-twitch muscle fiber is called type IIa (or fast-twitch oxidative glycolytic), and is conditioned from weight training with middle intensity workloads, and for a wide range of reps, longer duration.

Preferential development of type IIb muscle fibers is important to people who are involved in sports that require extreme bursts of muscle contractions, such as competitive weightlifting, powerlifting, sprinting, football, baseball, shot put, goal keepers, and the like. Your fast-twitch muscle fibers can be developed to perform over a range of heavy to middle to light intensity workloads. The extent to which you need to develop the type IIb muscle fiber energy systems depends on your performance goals, and what energy systems are needed to be best at your activities.

When type IIb muscle fibers are exercised correctly they get quite large, and store a resting level of **adenosine triphosphate** (ATP), and **creatine phosphate** (CP) (also called **phosphocreatine** (PCr). So, when a powerlifter attempts to squat 1000 pounds for one repetition, as ATP gets depleted, the CP is used to quickly as an immediate source of biochemical energy to replenish and make more ATP very, very quickly.
This is one reason why loading up with creatine monohydrate supplements results in increased strength and longer workouts. When you load up your body with higher amounts of creatine, your muscles eventually are able to increase the amount of creatine phosphate stored in them. In the process, muscle fibers also grow larger. Research has revealed that it is also important to keep on taking creatine supplements to maintain this higher then normal amount to total body creatine and creatine phosphate in your muscles. So from taking creatine supplements, during high intensity exercise and sports performance, there is more creatine phosphate to replenish ATP. Now keep in mind that these ATP – CP bioenergetics occurs in short timeframe, measured in seconds. This is why much of the research has proven that taking creatine is most beneficial to strength (Type II muscle fiber athletes) than endurance athletes.

From knowing about these muscle fiber bio-energetics, it is easy to understand why sports scientists though it would be beneficial to increase creatine level in an athletes body. During the course of over a decade of research, other benefits of taking creatine were revealed, in addition to creatine being a strength athlete performance enhancer as originally thought. Other benefits, such as increased muscle size and lean body are what have made creatine supplements one of the most popular and useful strength and bodybuilding supplements in the world.

This ready-to-go supply of ATP and CP in your muscle fibers, much of it is in the large Type II fibers, is referred to as the immediate energy source. While it lasts only a few seconds, it is important to explode in to action, and generate tremendous force for short periods of time. Also occurring during these seconds of all out effort is the splitting of glucose in the muscle fiber’s cellular fluid, to assist in the replenishment of ATP and CP. This is the biochemical step that forms pyruvate, or lactic acid as a by product (as further explained below). Once this immediate energy supply of ATP and CP is depleted, the ability to generate high intensity force is reduced, and some time is required for the muscles to rest, clear out waste products, rebuild the ATP – CP, and engage in another high intensity bout of exercise or work.
As strength athletes develop their muscles, i.e., more and more type II muscle fibers, the need for creatine supplementation becomes even more important. These bigger muscle fibers require more creatine to help maintain high levels of total creatine and creatine phosphate. So, with progressive strength and muscle size development, keep taking creatine to support your progress and peak athletic performance.

**FYI - Some Additional Muscle Bioenergetics Information**

As the immediate energy system is getting depleted of its capacity to produce ATP, glucose molecules (glycolytic energy production – producing energy from glucose) the muscle fibers is quickly split in half, which produces more ATP for muscle contractions to continue. If all out effort is maintained, lactic acid eventually builds at a rate faster than it can be cleared away, and muscle fatigue occurs. In the process of this type of exercise, these workloads actually stimulate development of type IIb and type IIa muscle fibers. Keeping in mind that type IIa muscle fibers have the capacity to develop and perform over a range of intensities and duration due to their glycolytic and oxidative abilities. As the workloads are reduced, a moderate intensity weight training set can be performed for a longer duration of time.

All of this bioenergetics stuff is important to realize, because it is your underlying energy system that you are actually training to build up a capacity of your muscles to develop and to store more energy, to accommodate different types of workloads, and eventually turn chemical energy in to mechanical energy to best suit your athletic needs. Additionally, the rapid production of energy from CP and or glucose in the type II muscle fibers occurs mostly without oxygen, which is why this type of muscular exertion is referred to anaerobic.

Slow-twitch muscle fibers metabolize glucose more slowly and completely than fast-twitch muscle fibers, and also use more fatty acids for the production of energy, in addition to glucose. This means that training and developing the slow-twitch muscle fibers will burn fat more readily. As described above, high intensity exercise uses primarily immediately available ATP, CP and glucose from muscle tissue (from glycogen stores) and glucose...
circulating in the blood stream as supplied from the liver. Therefore, anaerobic type of exercise is not very effective in burning body fat. Studies show that by varying the amounts of anaerobic and aerobic exercise you can achieve a diversity of body composition and performance results, which is ideal for general fitness. However, competitive athletes and bodybuilders have to be more selective, and train to develop their muscles to an extreme point to achieve athletic excellence.

Aerobic and anaerobic metabolic pathways are occurring all of the time, but different energy systems will employ one system more than the other. Depending on how your body is trained to best use the different energy systems is what makes the difference. Let’s look at an example. If you were to lift a one pound weight for several minutes, the slow-twitch muscle fibers in your arm muscle would be supplying most of the energy to do this type of low intensity, long duration work. But if you chose to lift up a thirty pound dumbbell, and began to do reps, your type IIb fast-twitch muscle fibers are activated and anaerobic energy systems are called upon to generate the energy need to produce this short duration, high intensity work. Keep in mind however, that the muscle fiber activation boundaries are not perfectly segregated and that at this level of all-out muscular effort, all of your muscle fibers are at work.

**The Intensity – Duration Muscle Fiber Connection**

So, what does all this talk about fast-twitch and slow-twitch muscle fibers have to do with you?

It opens up new possibilities to how you can use weight training to develop your body best for your sport or personal fitness goals. Let’s face, it’s hard pumping heavy loads of iron. But, maybe you do not need to. Very few athletes need to lift very heavy weights for a few repetitions like powerlifters and Olympic weight-lifters do. When you think about using weight training to improve your sports performance, ask yourself if being able to squat 1000 pounds once helps, or being able to run a marathon will make you better at your sport? Even in power sports like football there is a balance to developing muscles
that can produce powerful muscle contractions, but over and over again for peak athletic performance throughout the entire game.

**The Bodybuilder**

When you take a look at a professional competitive bodybuilder you see several types of athletes in one. Most bodybuilders have developed all of their muscle fibers to the maximum possible size, in particular both types of fast-twitch muscle fibers. As they get stronger, they get bigger. Even their warm-up sets contribute to building strength and muscle, in particular type IIa and type I muscle fibers. To illustrate the magnitude of type IIb and type IIa muscle fiber development, let us take a look at some impressive statistics from bodybuilding legend, Arnold Schwarzenegger.

In an article from Muscle & Fitness magazine, Arnold was reported to be able to lift the following weights and repetitions in the bench press: 500 pounds for one rep, 405 pounds for eight reps, 315 pounds for 25 reps, and 225 pounds for 60 reps. From a muscle fiber development standpoint Arnold’s ability to lift such an impressive amount of weights for a variety of repetitions is a direct reflection of his diversified muscle fiber development. I think most people would be satisfied with being able to bench press 225 pounds for one repetition. But being able to bench press 225 pounds for 60 repetitions demonstrates the strength-stamina potential that well developed fast-twitch muscle fibers have to offer, especially type IIa muscle fibers.

Bodybuilding legend, Ronnie Coleman, is reported to display similar diversified muscle fiber development and wide ranging weight lifting abilities. In fact, in one of his favorite exercises, the dumbbell lateral raise giant set, he is reported to lift (without stopping) 30 pound dumbbells for 25 reps, then 40 pounds for 15 reps, then 50 pounds for 10 reps, and 60 pounds for 8 reps. He performs two of these giant sets, about twice a month, and produced drastic gains in shoulder muscle development. This again demonstrates how variable weight training can be used to stimulate total muscle fiber development.
Muscle Fiber Recovery
There is another side to the muscle fiber story that concerns time for recovery; muscle fiber growth and repair. When training with heavy workloads for a few repetitions to develop type IIb muscle fibers, these muscle fibers breakdown, and need a few to several days to fully recover. When, resistance training with medium workloads, targeted at developing type IIa muscle fibers, these muscle fibers are more resistant to exercise induced damage, but still need a few days to recover. When using light workloads, for higher repetitions, less muscle damage occurs, and less rest is needed for muscle fiber recovery and repair.

In practice, when the purpose of your resistance training is for maximum muscle building, this means that it is best to alternate the intensity of your weight training sessions from workout to workout for maximum muscle building results. After a high intensity weight training day, you need to wait several days for your type IIb muscle fibers to fully recovery. But in the meantime, your muscles can endure medium and light intensity weight lifting sessions. Ideally, each training day should consist of a combination of high, medium and light resistance training intensities for different muscles.

Note however that these training-recover principles vary when applied to training for maximum sports performance, as the primary goal is not training for maximum muscle growth, but maximum sports-specific muscle performance. But, even in the context of sports performance training, the application of varying high intensity training sessions with medium and low intensity training sessions is viable, as your body cannot withstand the stress of high intensity training, day after day.

In fact, Russian scientists developed a technique to determine if their athletes, especially strength athletes, were over-training and if they needed to take a medium to low intensity training day versus a high intensity day. To do this, the scientists developed a quick test that measured the amounts of testosterone and cortisol in the saliva of the athletes. The athletes would get their saliva tested first thing in the morning. Depending on the relative
levels of testosterone and cortisol, the scientists would determine what intensity level of
training an athlete can handle that particular day. Generally speaking, when cortisol
levels are high, this is an indication of over-training, and a medium to low intensity
training day is best.
The moral to this story is that training smarter and not necessarily harder is what works
best. Too often when the gains slow down, individuals start training harder, and harder,
when in fact they might need to be staggering high-medium-low intensity workouts
smarter, and make sure that their nutrition and sports supplement programs are adequate.
Keep in mind that this approach is being applied at the level of the elite athlete, who
trains sometimes several hours a day. So, medium and low intensity training days, does
not mean you are not breaking a sweat, you are just not pushing yourself to the maximum
limit of your performance, like you would on a high intensity training day / workout.

There are some individual dynamics concerning recovery from weight training sessions
to also consider. Some people may recover quicker then others. In general, young people
recovery quicker then older people, and men recovery quicker then women. So while you
can follow general resistance training example programs, ultimately, as you become more
advanced, you will need to fine-tune your weight training to best suit your individuality.
This is why you need to keep a good training and nutrition log book; the evidence based,
scientific approach.

These are just some general rules to keep in mind for muscle building training.
Resistance training for sports performance is a bit more complicated. Keep in mind that
while advanced bodybuilders have huge muscles, this is what they are training for. They
are not training to improve their performance on the playing field. The research is clear
about one thing, that creatine will help benefit muscle building, strength building, and
strength sports performance efforts. So, if the gains in muscle mass increase have slowed
down, working out harder and longer may not be the answer. Resistance training smarter
may get you out of the rut that every athlete eventually falls in to.
Strength-To-Bodyweight Ratio

Most people don’t need to over develop their type IIb muscle fibers for a few reasons. First, it takes a tremendous amount of high intensity training (lifting extremely heavy weights for only a few to several repetitions at a time) to develop them. Second, most people don’t need to exert this huge amount of force in their daily life or recreational activity. And finally, there comes a point where an increase in maximum strength will result in an increase of body weight that is not practical.

This is where the concept of strength to body weight is important. Massive type IIb muscle fibers are generally too big and fatigue too quickly, making them impractical for competing in some sports and even performing daily chores. Most people want more strength and a modest amount of muscle size to improve their body build and functional strength, but they don’t need to build the massive physique of a powerlifter, bodybuilder, or football lineman.

Even sports that require strength and power don’t really require muscle development to the point of maximum power potential. For example, a football lineman needs a strong massive body to generate explosive muscle contractions and over-power their opponent. But if they were to spend the time in the gym lifting just like a powerlifter, and were able to generate enough force to squat 1000 pounds for one repetition, on the playing field they may only do extremely well for the first few plays. But eventually, would not be able to sustain this maximum burst of power over and over again. After a few more plays, fatigue would set in quicker, because adequate training time was not spent on developing the other fast twitch muscle fibers, type IIa, which give us the ability to produce powerful muscle contractions over and over again, and also to train the type IIb muscle fibers to recover more quickly, and replenish resting ATP and CP (PCr) levels faster. A lineman needs to maintain the same level of explosive strength off the line, perhaps more than 60 times during a game. Looking this example of the football player, it is easy to understand how creatine is an essential supplement to maximize explosive strength performance, and help promote strength stamina, throughout the game, in addition to a sport specific resistance training program.
Even in a strength sport like boxing, where explosive power for the knock-out punch is needed, muscle stamina and endurance is also important. Boxers are in the ring slugging it out for 3 minutes at a time, contracting their muscles over and over again as if they are performing a combination weightlifting giant set and short run around the track. Then they only get a minute of rest, and have to perform again for 3 minutes of all out, sustained effort. While powerlifters and bodybuilders are extremely strong athletes, I think you will agree that unless they knocked a well trained boxer out early in the first round, their ability to generate explosive muscle contractions in the second round would greatly be reduced, and continue to be reduced each round thereafter.

In fact, true “cross training” employs different types of exercise or sport activities to train your body’s different energy systems, and muscle fibers. Under these terms, the triathlon is not really cross training, because all of the sport activities are aerobic, long distance. None of them require maximum development of the fast-twitch muscle fibers and anaerobic energy systems.

A good example of a cross trained athlete is a decathlete. In the decathlon all of the energy systems need to be developed to excel at the different events. For example the shot put requires very short lived, extremely explosive strength. Other anaerobic strength events in the decathlon include the 100 meter sprint, long jump, high jump, 110 meter hurdles, discus, pole vault, and javelin, which need well developed fast twitch muscle fibers, both types. The 400 meter run tests the athlete’s type IIa muscle fiber development. This grueling sport event then ends with a grueling 1,500 meters aerobic run, which also relies on the anaerobic energy systems early in the race, and at the end of the race to sprint to the finish line, but also well developed level of high intensity aerobic performance-fitness; good type I muscle-fiber development. It is interesting to note however, while the decathlete is a tremendous athlete, this all around bio-energetic training does not result in these athletes breaking any specific event world records. This is another example of the delicate balance and precision that is required for sports specific training and muscle development (bio-energetic development).
So while you need strength, power, and stamina to repeat the muscle contractions over and over again, to what extent will be determined by your personal-fitness goals. Additionally, research studies have discovered that creatine supplementation can help improve your strength to weight ratio.

**Maintenance -- Use it or You’ll Lose it**

It is a well know medical fact that disuse of your body will lead to premature aging and premature death. Resistance training your entire body on a regular basis will keep your muscles in good working order. It will stimulate growth and development and keep you looking younger longer.

Another important point to remember in the “use or lose it” principle is that this is a lifelong commitment. There are no quick fixes to muscle building or weight loss, or three month miracle exercise programs. Once you achieve your strength and bodybuilding goals, this does not mean you stop training. You need to stick with it to experience lifelong benefits. So, when you reach your particular goals, continue training for maintenance. This may mean cutting back on the days and sets of weight training exercises you perform. But try to exercise each muscle group at least once or twice a week for maintenance of strength, muscle size, and the other health benefits of weight training. This goes double for your nutrition and nutrition supplement programs.

Following your performance nutrition plan all year round is best. Don’t sell yourself in to the idea that it is okay to let yourself go, and eat all the junk you want on the off-season. Winners of sports and life are consistent and always do things that are best for them to accomplish their goals. Be a winner, and stick to a healthy eating performance nutrition program all the time. Some of the research studies presented in the following chapters also reveal that creatine supplements can help maintain the gains, as well as help promote getting faster and better gains in muscle mass, strength, and athletic performance.
The purpose of this section is to provide you with a comprehensive review of the creatine research studies and conclusions of these studies. It brings to you the results of more than a decade of scientific creatine supplement research conducted on humans.

When reading through this section, keep in mind that while the science process in not perfect, but it is an important way to help separate fact from fiction, reality from marketing hype, and what works from what does not work. You and I can self prescribe different training and nutrition programs based on general scientific principles and what other people have done to achieve the same results (observations) or based on the results of scientific studies. But, how do we know we are doing it the best way?

Also, keep in mind that science does not always have all of the answers at any giving point in time, due to the fact that the research may not have been performed yet. In sum, the best approach to take to promote health and athletic performance is an evidence based approach. This approach combines the scientific discoveries and scientific insights with case studies and observations at the individual, group and population level. When taking a novel supplement substance like creatine, research is important to verify what the safe and effective levels of consumption really are. This is why it is eventually necessary to reach conclusions of use based on the “body” of scientific research; more then one or a few studies. Speculation is a good starting point, but scientific evidence is needed to verify optimum application. For example, based on the results of numerous scientific studies, it is concluded that taking a certain amount of a creatine monohydrate supplement will yield certain benefits.

In the case of creatine supplementation, the scientific process began more then a century ago when creatine was discovered as a biological substance. Eventually scientists
determined the role of creatine in the human body as a building block for the energy producing substance, creatine phosphate (also referred to as phosphocreatine). But it took until the late 1980’s for scientists to start to experiment with creatine supplements to determine the effects creatine would have on the bioenergetics of the human body.

It was actually in the early 1990’s that the first independent research studies began to appear in the scientific journals about the effects creatine monohydrate supplement taking had on the body relative to athletic performance. One reason it took so long to get from the point of the discovery of creatine, to creatine supplement taking by humans, is the nature of the scientific process. For one thing, when it comes to humans, the scientific process demands that there is some evidence that experimental substance in question will be safe. This is a lengthy process that starts with toxicology experiments being conducted using microbes. Based on the microbe tests, the safety experiments advance to using more complex organisms (animals). Eventually, after the standard testing is completed, which can take decades, assuming a substance is determined to be safe, at which point human testing begins. As more and more scientific studies have been conducted using creatine monohydrate some conclusions have been reached, but at the same time, new questions arise. What started out as a substance thought to help increase strength, the list of benefits from taking creatine monohydrate has grown, and continues to grow from the proliferation of ongoing research studies, which reveal new discovers from taking creatine supplements.

The Quest for Growth
The quest for growth is not limited to bodybuilders and other athletes. Much of the research conducted using creatine and other growth substances starts using animals. First for safety determination, but also to determine how a potential growth substance works in animals of economic importance, such as those animals grown for human use and consumption.

The practice of doping animals raised for human consumption has become quite controversial in recent years. For example, the human health issues related to the
consumption of growth hormone and anabolic steroids found in some animal meats and other animal products, such as milk. There is even research on how creatine and other supplements, like carnitine, promote growth and performance in race animals, such as horses and dogs. While this type of research is useful however, the results cannot be directly applied to humans. Due to animal species differences, scientific research conducted on humans is ultimately required to reach conclusions about the effects a particular substance will have on the human body.

**About The Creatine Research Reviews in This Section**

I chose to present the scientific evidence in two ways: first, by providing a summary of what the body of research concludes about how creatine supplementation affects the human in terms of growth, energy production, and athletic performance. This is accomplished primarily from a combination of reporting on the results of single studies, and also scientific review studies. Review studies are very useful in science, as they serve to review and evaluate the results of several or more scientific studies. In the case of creatine supplementation there are now a few review studies that reviewed and evaluated the results of over 200 creatine supplementation studies.

The second way I present the scientific evidence is to actually take you through the results of the most recent scientific studies, study by study. In this way you will gain detailed insights into the most recent results of the actual research performed on creatine supplementation. This study by study review presentation follows the format of a scientific study abstract. This includes the study reference information; author(s), title of the study, and journal publication details. Then the overview of the study in abstract form: the primary intent of the study; the study methods (people used, dosage regimens, and duration of the study; the study results / findings; and the conclusions of the research findings.

The scientific process thrives on duplication and validation of the results of previous studies. This is one reason why there are so many studies conducted on creatine, to see if the results of the previous researchers are valid. However, even with this verification
process, scientists sometimes screw up. For example, not using a high quality supplement, or using a bad study designs. Sometimes scientists get caught up in the “blind leading the blind” syndrome; however, eventually the scientific truth reveals itself. In the case of creatine supplementation, the scientific truth began to reveal itself from the first human studies, due to that the fact that supplementation with creatine monohydrate produced significantly measurable effects.

CREATINE RESEARCH – WEIGHING IN THE EVIDENCE

In the 1980’s when I started using experimental creatine, I recorded increases in muscle mass and strength. Then, I recruited bodybuilders and started to measure their results. My interest in creatine started during the creation of my bio-energetic based Dynamic Nutrition model, and my curiosity about creatine was stimulated after reading a landmark research review by J.B. Walker, published back in 1979. This research review focused on the chemistry, biochemistry and functionality of creatine, and was based mostly on research studies that used tissue cultures and animals. In this early research review, Walker proposed the possible bio-energetic effects of creatine loading, and call for more research in this area of focus.

Since the early 1990’s, the type of human creatine supplement research has progressed as follows:

➢ To determine what the effects were of creatine supplementation on the levels of total creatine and creatine phosphate in the body.
➢ Continuing research on testing various dosage amounts and duration of use, and the effects on the levels of total creatine and creatine phosphate in the body.
➢ Determination of synergistic ingredients to enhance the uptake and beneficial effects of creatine monohydrate.
➢ The effects of creatine supplementation on body composition.
➢ The effects of creatine supplementation on strength performance and work load ability.
➢ The effects of creatine supplementation in males & females, young and old.
➢ The effects of creatine supplementation on athletic performance.
➢ Determine optimum creatine dosing regimens.
➢ Evaluation of new forms of creatine.

For the sake of the following research study reviews, unless otherwise noted, creatine means creatine monohydrate. If the study used a different form of creatine, the form is clearly identified. Keep in mind that these recent research studies are in addition to
numerous research studies published since 1992, and the results need to be considered in the context of the total body of scientific evidence, as evidenced from the research reviews.

Also note that most studies compare one or more experimental groups, creatine taking groups, and compare the results of the creatine takers to a placebo group. Sometimes, research studies even have a control group in addition to the experimental group and placebo taking group. Comparing the results of an experimental group (creatine takers) to the results of a placebo taking group allows the researchers to determine if there are any beneficial effects from taking creatine supplements. In over 85% of the more than 200 clinical studies using creatine monohydrate, significant beneficial effects were observed in the creatine taking groups of individuals. In most of the studies where a significant effect was not observed, this was primarily due to inadequate creatine intake (studies testing the lower range of beneficial intake), or athletes not expected to benefit from taking creatine, such as long-distance endurance athletes. Studies that did not find a significant improvement, did not report a negative effect from creatine use, in other words, creatine either produced either significantly beneficial effects, or neutral effects.

Additional study reviews will be presented in Sections 5 (dealing with taking creatine) and 6 (dealing with different forms of creatine). As an aside, at the writing of this 2005 edition, there were no research studies published using creatine ethyl ester; see Section 6 for more information about creatine ethyl ester and other forms of creatine.

The table on the next page summarizes the beneficial effects of taking creatine monohydrate supplements. The list of beneficial effects has grown quite significantly since 1992, when the first benefits of creatine supplementation were reported to increase total creatine and creatine phosphate body content. One thing is clear from all of this research, if you are exercising to improve strength, muscle mass and physical performance, creatine works to enhance these effects more significantly. The most recent research also reports that athletes taking creatine are actually reported to reduce the risk of all injuries, including muscle cramps.
**Summary of Beneficial Effects of Creatine Monohydrate Supplementation**

This table includes a summary of the major conclusions about how creatine monohydrate supplementation improves body composition, physiology, physical performance and athletic performance.

<table>
<thead>
<tr>
<th>Body Composition and Physiology Related Improvements</th>
<th>Athletic Performance Related Improvements</th>
<th>Reported In Research Studies:</th>
<th>Sports In Which Improvements are Expected Due to the Bio-energetic Nature of the Sport:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Promotes greater gains in increasing FFM (Fat Free Mass, which includes muscle mass).</td>
<td>- Improves rate of training induced gains.</td>
<td>- Bodybuilding</td>
<td>- Sports involving short-term sustained or periodic maximum effort strength and power, such as:</td>
</tr>
<tr>
<td>- Increases muscle fiber size (hypertrophy).</td>
<td>- Improves maximal strength and power about 15%.</td>
<td>- Football</td>
<td>- Basketball</td>
</tr>
<tr>
<td>- Increases muscle mass.</td>
<td>- Improves work performed during maximal effort muscle contractions about 15%.</td>
<td>- Handball / Squash</td>
<td>- Bobsledding</td>
</tr>
<tr>
<td>- Increases myosin muscle fiber content.</td>
<td>- Improves anaerobic power.</td>
<td>- Hockey</td>
<td>- Bowling</td>
</tr>
<tr>
<td>- Improves strength training adaptations.</td>
<td>- Improves single-effort sprint performance about 5%.</td>
<td>- Military Performance</td>
<td>- Boxing</td>
</tr>
<tr>
<td>- Improves limb blood flow.</td>
<td>- Improves multiple sprint performance.</td>
<td>- Powerlifting</td>
<td>- Canoeing / Kayaking</td>
</tr>
<tr>
<td>- Reduced ammonia levels.</td>
<td>- Improves worked performed during repetitive sprint performance about 15%.</td>
<td>- Softball / Baseball</td>
<td>- Curling</td>
</tr>
<tr>
<td>- Reduced lactate levels.</td>
<td>- Improves performance during exercise of high to maximal intensity.</td>
<td>- Soccer</td>
<td>- Decathlon</td>
</tr>
<tr>
<td>- Raises lactate threshold.</td>
<td>- Increased number of weightlifting repetitions.</td>
<td>- Sprint running</td>
<td>- Fencing</td>
</tr>
<tr>
<td>- Reduces cholesterol levels.</td>
<td>- Increased number of weightlifting sets.</td>
<td>- Sprint cycling</td>
<td>- Golf</td>
</tr>
<tr>
<td>- Reduces homocysteine levels.</td>
<td>- Greater gains in vertical jump height and power.</td>
<td>- Sprint rowing</td>
<td>- Ice Skating</td>
</tr>
</tbody>
</table>

Benefits have been measured in men and women; young and old (teenagers to over 70 years of age); inactive, active and athletic individuals.

Note: creatine supplementation has not been shown to increase long-term endurance physical / sport / exercise performance. Other supplements, such as carnitine, certain carbohydrates, etc. have been reported to stimulate significant improvements. You can read about these improvements in a separate e-book report, on Ergogenic Aids for Enhancing Long-term Endurance Sports.

**Major Research Reviews Include:**

CREATINE RESEARCH – THE EARLY YEARS

The following is an overview one of the first studies to report the benefits of taking creatine monohydrate supplements, followed by one of the first studies to report on the ability of taking creatine supplements to increase the rate of resynthesis of phosphocreatine in the muscles.


This study was undertaken to test if creatine supplement was absorbed, and if continued resulted in an increase in the total creatine pool in muscle. An additional effect of exercise upon creatine uptake into muscle was also investigated. Low doses creatine monohydrate, 1 gram, produced only a modest rise in the plasma creatine concentration. But, 5 grams resulted in a mean peak after 1 hour of 795 mumol/l in three subjects weighing 76-87 kg. Repeated dosing with 5 grams every 2 hours sustained the plasma concentration at around 1000 mumol/l. A single 5 gram dose of corresponds to the creatine content of 1.1 kilograms of fresh, uncooked steak. Supplementation with 5 grams of creatine monohydrate, four or six times a day for 2 or more days resulted in a significant increase in the total creatine content of the quadriceps femoris muscle measured in 17 subjects. The increase in total creatine muscle content was greater for subjects who had lower initial total creatine content. The increase was as much as 50% increase in total muscle creatine content in some individuals. Approximately 20% or more of the creatine taken up was measured as phosphocreatine. There were no changes apparent in the muscle ATP content observed during this study. Which makes sense, as creatine increases creatine phosphate (phosphocreatine) levels in muscles. This is the study that set the stage for other researchers to follow, and lead to the practice of short-term (several days) creatine loading.


Biopsy samples were obtained from the vastus lateralis muscle of eight subjects after 0, 20, 60, and 120 s of recovery from intense electrically evoked isometric contraction. Later (10 days), the same procedures were performed using the other leg, but subjects ingested 20 grams of creatine per day for the preceding 5 days before the test. Muscle ATP, phosphocreatine, free Cr, and lactate concentrations were measured. In five of the eight subjects, creatine ingestion substantially increased muscle total creatine concentration, and phosphocreatine resynthesis during recovery. The data suggest that a dietary-induced increase in muscle total creatine concentration can increase phosphocreatine resynthesis during the 2nd minute of recovery from intense contraction.
RECENT CREATINE RESEARCH REVIEWS

The following presents reviews of some of the most recent research (between 1999 and 2004) using creatine monohydrate. These reviews cover a wide range of research topics, such as, reconfirmation of creatine supplementation causing increases in muscle strength and building; creatine supplementation effects on young and old athletes and nonathletes; effects on sports performance; and effects on men and women.

RESEARCH RELATED TO CREATINE MONOHYDRATE SUPPLEMENTATION AND MUSCLE BUILDING AND STRENGTH


In this study thirty-one weight-trained men were randomly assigned in a double-blind manner to a placebo group, a Creatine monohydrate group (2.5 g of Creatine per day), or a Magnesium Creatine group (2.5 g of Creatine per day). Baseline data were collected for the bench press 1 repetition maximum (RM) and maximal work completed during a fatigue set at 70% of the IRM. Following 10 days of Creatine supplementation, follow-up tests were completed for the dependent variables. Groups were similar when the change in IRM was evaluated either absolutely or relatively. After 10 days of supplementation, both the Creatine monohydrate and the magnesium Creatine groups had significantly larger increases in maximal work completed during a set of bench presses at 70% of the one repetition maximum, and 1 repetition maximum, both of these experimental groups were similar. This study provides some evidence that low dosages of creatine monohydrate may be an effective means of enhance muscle strength performance after a period of short-term ingestion. Also, the use of magnesium creatine offered no additional benefits over creatine monohydrate, and compared to higher dosage creatine studies, the improvements were not as big.


This study evaluated the effects of creatine monohydrate supplementation on muscle strength in conjunction with resistance training in nonresistance-trained males. Nineteen nonresistance-trained males underwent 4 weeks of resistance training 3 days per week. The creatine supplement program they followed was taking 20 grams creatine plus 140 grams glucose per day for a 7 day loading period. This loading periods was followed by subjects taking 5 grams creatine and 35 grams glucose per day for a 21 day maintenance period; or a placebo regimen of taking 160 grams glucose per day during the loading period and 40 grams of glucose per day during the maintenance period. Seven of the 9 subjects taking creatine were considered responders based on their increase in strength and body mass. The results indicated that creatine supplementation can increase muscle strength in association with strength training but only in subjects whose estimated creatine uptake and body mass are significantly increased, reporting that the greater the creatine uptake and associated body mass changes, the greater the performance gains. This study also illustrates that taking glucose with creatine does not guarantee a better uptake of creatine, as 2 of the 9 subjects did not respond to the creatine plus glucose supplement regimen.

The researchers examined forearm muscles of twelve healthy male subjects during a 10 second maximal dynamic handgrip exercise before and after ingestion with 30 grams of creatine monohydrate or placebo per day for 14 days. Creatine supplementation produced an average 11.5% increase in the resting muscle phosphocreatine concentration and a 65.0% increase in the phosphocreatine degradation during exercise, and a 15.1% increase in the mean power output. ATP synthesis rate through phosphocreatine hydrolysis positively correlated with mean power output during exercise in all twelve subjects after creatine treatment. The results suggest that creatine supplementation enhanced phosphocreatine degradation during exercise. These results indicate an improvement in performance during exercise was associated with the increased phosphocreatine availability for the synthesis of ATP.


These researchers measured the effects of 3 days of creatine monohydrate supplementation on repeated sprint performance and thigh muscle volume in elite power athletes. Ten male and ten female athletes were randomly assigned to a creatine or placebo group. Subjects completed six maximal 10-second cycle sprints interspersed with 60 seconds of recovery before and after 3 days of creatine supplementation. Creatine supplementation was at the rate of 0.35 grams per kilogram of fat-free mass, or in the placebo group, taking a maltodextrin supplement. Creatine supplementation resulted in statistically significant increases in body mass, about 0.9 kilograms, increased total work during the first sprint, and peak power during sprints 2 to 6. Total work and peak power values for males were greater than those for females during the first sprints. However, the reverse was true during the last three sprints. Imaging data showed a 6.6% increase in thigh volume in five of six creatine subjects. The researchers concluded that creatine supplementation can increase thigh muscle volume and may enhance cycle sprint performance in elite power athletes, and that this effect is greater in females as sprints were repeated.


This study evaluated the effects of both creatine monohydrate loading and prolonged supplementation on muscle creatine content, body composition, muscle and whole-body oxidative capacity, substrate utilization during submaximal exercise, and on repeated supramaximal sprint, as well as endurance-type time-trial performance on a cycle ergometer. Twenty subjects participated in the study. During the 5-day loading period, 20 grams per day of creatine was ingested, followed by a 6 weeks period of ingesting 2 grams per day of creatine. Creatine loading increased muscle free creatine, creatine phosphate and total creatine content. The use of the 2 grams per day maintenance dose, resulted in a decline in both the elevated creatine phosphate and total creatine content and maintenance of the free creatine concentration. Both the short-term and long-term creatine supplementation improved performance during repeated supramaximal sprints on a cycle ergometer. However, whole-body and muscle oxidative capacity, substrate utilization and time-trial performance were not affected. The increase in body mass following creatine loading was maintained after 6 weeks of continued supplementation and accounted for by a corresponding increase in fat-free mass. This study provides evidence that prolonged creatine supplementation in humans does not increase muscle or whole-body oxidative capacity and, as such, does not influence substrate utilization or performance during endurance cycling exercise, but creatine supplementation induces an increase in fat-free body mass.
CREATINE ENHANCES STRENGTH AND BODY COMPOSITION IN OLDER ADULTS TOO


This research study compared the effects of short-term creatine monohydrate supplementation on muscle phosphocreatine, blood and urine creatine levels, and urine creatinine levels in elderly and young subjects. Eight young male subjects average age 24 years, and seven older male subjects average age 70 years. The subjects ingested 20 grams per day of creatine for 5 days. At the start of the study it was observed that the older subjects had significantly higher baseline plasma creatine levels than young subjects (68.5 versus 34.9 micromol per liter). There were no significant differences between groups in plasma creatine pharmacokinetic parameters, such as area under the curve, elimination rate constant, absorption rate constant, time to maximum concentration, and maximum concentration. After the creatine supplementation period, urine creatine increased in both groups. Urine creatinine did not change as a result of creatine supplementation. The young males showed a significantly greater increase in muscle phosphocreatine compared with the older males; young males 27.6 versus old males 25.7 mmol kg^-1 ww. There were no differences in blood or urine creatine between groups in response to creatine supplementation.


These researchers sought to determine if creatine monohydrate supplementation would enhance the increases in strength and fat-free mass that develop during resistance exercise training in older adults. Twenty-eight healthy men and women over the age of 65 years participated in a whole-body resistance exercise program 3 days per week for 14 weeks. The study participants were randomly assigned, in a double-blind fashion, to receive either creatine monohydrate at 5 grams per day plus 2 grams of dextrose (14 subjects) or placebo of 7 grams of dextrose (14 subjects). At the end of the study period, significant increases in all measurements of strength and functional tasks, and muscle fiber area occurred for both the placebo and creatine taking groups. However, the creatine taking group experienced greater increases in fat-free mass and total body mass. Additionally, the creatine taking group also had a greater increase in isometric knee extension strength in both men and women, and also greater gains in isometric dorsiflexion strength, but in men only. A significant increase in intramuscular total creatine in the creatine taking group was also measured. There were no significant side effects of treatment or exercise training. This study confirms that heavy resistance exercise training can safely increase muscle strength and functional capacity in older adults, and the addition of creatine supplementation can stimulate increases in total and fat-free mass, and gains muscle strength greater then resistance training alone.


These researchers examined the effects of 7 days of creatine supplementation in normally active older men (59-72 yr) by using a double-blind, placebo-controlled design. Subjects were randomly assigned into creatine (10 subjects) and placebo (8 subjects) groups. The subjects consumed creatine monohydrate supplement at the rate of 0.3 grams per kilogram of body weight. The results indicated that 7 days of creatine supplementation is effective at increasing several indices of muscle performance, including functional tests in older men without adverse side effects. The researchers point out that creatine supplementation may be a useful therapeutic strategy for older adults to attenuate loss in muscle strength and performance of functional living tasks.
**CREATINE AND MYOSIN GROWTH**


This research study examined the effects of 12 weeks of creatine supplementation and heavy resistance training on muscle strength and myosin heavy chain (MHC) isoform mRNA and protein expression. In this study, twenty-two untrained male subjects were randomly assigned to either a control group, placebo group, or a creatine supplement – resistance training group in a double-blind fashion. Muscle biopsies were obtained before and after 12 weeks of heavy resistance training. The placebo and control groups trained three times a week using three sets of 6-8 repetitions at 85-90% 1-repetition maximum on the leg press, knee extension, and knee curl exercises. The creatine – resistance training group ingested 6 grams per day of creatine for 12 weeks. The following is an overview of the results of this 12 week study:

- There were no significant differences for percent body fat between the groups.
- Creatine supplement taking and resistance training produced significant increases in total body mass and fat-free mass, thigh volume, muscle strength, and myofibrillar protein, compared to the other groups.
- Regarding type I, Ila, and IIx muscle fibers, and MHC mRNA expression, the creatine taking and resistance training group experienced significantly greater improvements compared to the other groups.

The researchers concluded that long-term creatine supplementation increases muscle strength and size, possibly as a result of increased myosin heavy chain synthesis.
CREATINE AND ENERGY EXPENDITURE AND LIMB BLOOD FLOW


This research study determined the effects of 28 days of oral creatine ingestion, days 1 to 5, at an intake of 20 grams per day, taken in 5 gram dosages, 4 times daily. During days 6 to 28, 10 grams per day was ingested, taken in 5 grams dosages, twice daily. Creatine was taken by people who did not resistance or people who resistance trained about five hours per week. This study used a double-blind, placebo-controlled design, 30 healthy male volunteers (21 +/- 3 years; 18 to 30 years) were randomly assigned to 1 of 3 groups; pure creatine monohydrate no training (10 males), creatine plus resistance training (10 males), or placebo plus resistance training 10 males).

Body composition, body mass, bench and leg press 1 repetition maximum, resting metabolic rate, and forearm and calf limb blood flow were obtained on all 30 subjects on 3 occasions beginning at approximately 6:00 AM following an overnight fast and 24 hours removed from the last training session; baseline (day 0), and 7 days and 29 days following the interventions. No differences existed among groups at baseline for any of the variables measured. The following summarizes the results:

- Body mass increased significantly in creatine and creatine & resistance training groups, but remained unchanged in the placebo & resistance training group.
- Fat-free mass increased significantly in the creatine & resistance training group (about 1.7 kilograms) and showed a non-significant tendency to increase in the creatine taking group (0.9 kilograms).
- Following the 28-day period, all groups significantly increased bench press: creatine (average 77.3 to 83.2 kilograms; creatine & resistance training (average 76.8 to 90.5 kilograms; placebo & resistance training (average 76.0 to 85.5 kilograms), and leg press; creatine (average 205.5 to 238.6 kg; creatine & resistance training (average 167.7 to 238.6 kg; placebo & resistance training (average 200.5 to 255 kg) in 1 repetition maximum muscular strength testing.
- It was noted that the creatine & resistance training program improved significantly more on the leg press IRM than the creatine and placebo & resistance training groups, and the bench press IRM than the creatine group.
- Calf (30%) and forearm (38%) blood flow increased significantly in the creatine & resistance training group, but remained unchanged in the creatine and placebo & resistance training groups.
- Resting metabolic rate increased in the creatine group (average 1,860.1 to 1,907 kcal/day) and in the creatine & resistance training group (average 1,971.4 to 2,085.7 kcal/day), but remained unchanged in the placebo & resistance training group.
- Additionally total cholesterol decreased significantly in creatine & resistance training group (-9.9%; 172 +/- 27 to 155 mg/dL) compared with the creatine group (174 to 178 mg/dL) and placebo & resistance training group (162 to 161 mg/dL).

These findings provide more evidence that the addition of creatine supplementation to resistance training significantly increases total and fat-free body mass, muscular strength, peripheral blood flow, and resting energy expenditure and even improves blood cholesterol levels.
CREATINE SUPPLEMENT TAKING VEGETARIANS VERSUS NON-VEGETARIANS


The purpose of this study was to compare the change in muscle creatine, muscle fiber morphology, body composition, hydration status, and exercise performance between vegetarians and nonvegetarians with 8 weeks of creatine supplementation and resistance training. Eighteen vegetarian and 24 non-vegetarian subjects, age range 19-55 years old, were randomly assigned (double blind) to four groups: Ten vegetarians taking creatine.
Eight vegetarians taking placebo.
Twelve non-vegetarians taking creatine.
Twelve non-vegetarians taking placebo.

All of the subjects participated in the same 8 week resistance-training program. Creatine taking subjects took creatine based on their lean tissue mass at the rate of 0.25 grams per kilogram of lean tissue mass per day for 7 days, and 0.0625 grams per kilogram of lean tissue mass per day for 49 days. Initial biopsy sample results of muscle fiber composition revealed that vegetarian muscle fibers had an initial lower creatine and phosphocreatine content then non-vegetarians (vegetarians were 117 mmol per kilogram and nonvegetarians were 130 mmol per kilogram. After the study period, creatine taking subjects experienced a greater increase in phosphocreatine muscle levels, total creatine muscle levels, bench-press strength, isokinetic work, Type II fiber area, and whole-body lean tissue compared with subjects taking placebo.

Vegetarians who took creatine had a greater increase in total creatine, phosphocreatine, lean tissue, and total work performance than non-vegetarians. The change in muscle total creatine was significantly correlated with initial muscle total creatine and the change in lean tissue mass and exercise performance. The findings of this study confirm an ergogenic effect of taking creatine during resistance training and suggest that subjects with initially lower levels of muscle total creatine, like the vegetarians, are more responsive to supplementation.

CREATINE REVIEW ARTICLE


This researcher conducted a review of the scientific evidence regarding creatine supplementation. The primary ways creatine supplementation is thought to be responsible for any ergogenic effect (performance enhancing effect) includes:
- increased stores of muscle phosphocreatine (PCr)
- faster regeneration of PCr during exercise recovery
- enhanced adenosine triphosphate (ATP) production from glycolysis secondary to increased hydrogen ion buffering,
- possible shortened of contraction muscle relaxation time.
- Benefits in increasing muscle mass and high intensity power gains.

Additional, when creatine supplementation is combined with strength training for longer periods of time, 4 or more weeks, the extra creatine may alter muscle protein metabolism directly (via decreasing protein breakdown or increasing synthesis) and/or indirectly as a result of a greater training load made possible by its acute ergogenic effects on strength and power. Based on his review of the scientific studies, Lemon further points out that creatine supplementation does not appear to have any adverse side effects, at least with short-term use, base on the studies he reviewed.
CREATINE MONOHYDRATE SUPPLEMENTS AND WOMEN


This study measured the effects of 2 and 5 days of creatine monohydrate loading on anaerobic working capacity in women. Ten physically active women randomly received 2 treatments separated by a 5 week washout period: 1) 18 grams dextrose as placebo; or 2) 5.0 grams of creatine monohydrate plus 18 grams of dextrose taken 4 times per day for 5 days. The Creatine supplement increased anaerobic working capacity by 22.1% after 5 days of loading, the placebo did not. A significant increase in body weight was not observed during this 5 day study. These results show that creatine supplementation is effective for increasing anaerobic working capacity in women following 5 days of loading, but did not produce an associated increase in body weight during this short period of time.


This research study investigated the effect of creatine monohydrate supplementation upon muscle function, thigh circumference, and body weight in women. Twenty-two college-age women participated in the study. Subjects in the creatine taking group ingested 0.5 grams per kilogram of fat free body mass per day of creatine monohydrate, split in to one fourth dosage, taken four times per day, for five days. Resistance exercise was not permitted during this five day period. After the five day ingestion phase was completed, measurements that were taken at the start of the study were taken again. Improvements in muscle strength performance were observed in the creatine taking women, but a significant gain in body mass was not observed in this short-term study.

NO SIDE EFFECTS FROM CREATINE SUPPLEMENT TAKING


This study was undertaken to determine if any side effects would occur from taking a creatine monohydrate supplement. Twenty men were randomly assigned to a control or an experimental creatine supplement taking group. Subjects were examined for musculotendinous stiffness of the triceps surae and for numerous performance indices before and after the creatine ingestion period. It was determined that the creatine taking group experienced a significant increase in body mass, and also an increase in jump height performance. No increase was found for musculotendinous stiffness from taking creatine. The findings of this study do not support the speculation that creatine supplementation causes muscular strain injuries. Additionally, the increase in jump performance demonstrates the performance enhancement in activities requiring maximal muscle power output.

CREATINE AND ATHLETIC PERFORMANCE

Creatine Monohydrate Supplementation and Wrestler Performance


Twenty active international level wrestlers participated in this study, age range 22 to 27 years old; 10 in
the experimental group and 10 in the placebo group. The daily dosage of creatine monohydrate of 5 grams, 4 times per day or placebo was divided into 4 equal amounts. Every 5 grams of supplement was dissolved in 250 ml water and it was given to the subjects 1 hour before breakfast, lunch, dinner, and workout session. Subjects underwent a 30-second Wingate Anaerobic tests until exhaustion in pre- and post-tests. The results of the study concluded that the short-term high dose creatine supplementation had a beneficial, ergogenic effect on anaerobic capacity of elite wrestlers.


The purpose of this study was to determine if creatine monohydrate supplementation with carbohydrate ingestion during recovery period after rapid body mass reduction would accelerate the restoration of body mass and physical performance in well-trained wrestlers. A double-blind, placebo-controlled crossover study was conducted using five young healthy male wrestlers. These wrestlers reduced their body mass by 4.5-5.3%. Then, during a 17 hour recovery period the wrestlers consumed a controlled diet supplemented in random order with glucose or with glucose plus creatine monohydrate. The results of this study indicated that creatine supplementation with glucose ingestion during the 17 hour recovery period from rapid body mass loss did not accelerate the restoration of body mass. However, the creatine supplementation did stimulate the regain of physical performance in maximal intensity efforts in well-trained wrestlers in this one day test period.

**Creatine and Swimming Performance**


This study examined the effects of creatine monohydrate supplementation using 8 male and 7 female collegiate Division III swimmers, randomly assigned to a creatine taking or placebo taking group. The creatine takers took 0.3 grams creatine per kilogram of body mass for a 5 day loading period, and then 2.25 grams of creatine for nine days, regardless of body weight. To test effects of creatine taking on swimming performance, a 50 yard and 100 yard sprint was performed prior to and following the supplementation regimens. The group taking the creatine decreased their finish times in both the 50 yard and 100 yard sprints. This provides scientific evidence that creatine supplementation is effective for increasing swimming sprint performance and speed in the 50 and 100 yard swimming events.

**Creatine Monohydrate And Sodium Bicarbonate In Interval Swimming.**


This study looked at the effect of simultaneous supplementation of creatine monohydrate and sodium bicarbonate on consecutive maximal swims. Sixteen competitive male and female swimmers completed, in a randomized order, two different treatments; a placebo or a combination of creatine and sodium bicarbonate. There was 30 days of washout period between treatments in a double-blind crossover procedure. Both treatments consisted of placebo or creatine supplementation, 20 grams per day, in 6 days. However, in the morning of the seventh day, there was placebo or sodium bicarbonate supplementation, 0.3 grams per kilogram of body weight, during 2 hours before a warm-up for 2 maximal 100 meter freestyle swims. The maximal swims were performed with a recovery period of 10 minutes in between. The first swims were similar, but the time of the second versus the first 100 meter swimming time was 0.9 seconds less in the combination group than in placebo. Mean blood pH was higher in the
combination group than in placebo after supplementation on the test day. Mean blood lactate increased during the swims, but there were no differences in peak blood lactate between the combination group and placebo. The data indicate that creatine loading for several days, one dosage of sodium bicarbonate enhanced performance in consecutive maximal swims.

Creatine and Soccer Performance


The purpose of this study was to examine the effects of creatine monohydrate supplementation on soccer-specific performance in young soccer players. Twenty young male soccer players (16.6 +/- 1.9 years) participated in the study and were matched and allocated to 2 randomly assigned trials: ingesting creatine monohydrate supplement (3 x 10- gram doses) or placebo for 7 days. Before and after the supplementation each subject underwent a series of soccer specific skill tests: dribble test, sprint-power test, endurance test, and vertical jump test. Specific dribble test times improved significantly in the creatine group. Sprint power test times were significantly improved after creatine-monohydrate supplementation, 2.7 seconds placebo group versus 2.2 seconds creatine group. Vertical jump height was also significantly increased in from taking creatine; 49.2 centimeters in the placebo group versus 55.1 centimeters in the creatine group. There were no changes in specific endurance test results within or between trials. The main findings of this study indicate that supplementation with creatine in young soccer players improved soccer specific skill performance compared with ingestion of placebo.


This study examined the effects of creatine supplementation on the performance of elite female soccer players. On two occasions, 7 days apart, 12 players performed 5 x 11minute exercise testing blocks interspersed with 1 minute of rest. Each block consisted of 11 all out 20 meter running sprints, 2 agility runs, and 1 precision ball kicking drill, separated by recovery of 20 meter walks, jogs, and runs. The creatine group ingested 20 grams of creatine for 6 days; 5 grams, 4 times per day. The placebo group ingested the same dosage of a glucose polymer. After the 6 days of taking creatine a significant increase in body mass was measured, about 1 kilogram on average. No overall change in 20 meter sprint times and agility run times were observed. But the creatine group achieved faster post supplementation times in sprints 11, 13, 14, 16, 21, 23, 25, 32, and 39, and agility runs 3, 5, and 8. The accuracy of shooting the ball was unaffected in both groups. The researchers concluded that short-term creatine monohydrate supplementation improved performance of some repeated sprint and agility tasks simulating soccer match play, and increased body mass significantly.

Creatine and Elite Rowers Performance


The effects of creatine monohydrate supplementation on aerobic and anaerobic performance was investigated in 16 elite male rowers during a 7-day training period. The creatine taking athletes took 20 grams of creatine for 5 days. Before and after the test period, subjects performed two exercise tests on a rowing ergometer: (a) incremental exercise consisting of 3-minute stage durations and increased by 50 Watt until exhaustion; and (b) an all-out anaerobic exercise performed against a constant load of 7 Watts/kg. Heart rate and blood lactate concentrations were measured during exercise and recovery. The
results were mixed, in that creatine supplementation caused more of a beneficial effect than placebo in some of the parameters tested. Maximal power output did not significantly differ after the treatment in either group. The mean individual lactate threshold rose significantly after creatine treatment. During the anaerobic test the athletes supplemented with creatine were able to continue rowing longer. No significant differences were found between groups in blood lactate after the all-out exercise. The researchers pointed out that the results of this study indicate that in elite rowers creatine supplementation improves endurance, as expressed by the individual lactate threshold, and anaerobic performance, when compared to athletes taking just a placebo.

Creatine and Sprint Cycling Performance


This study examined the effect of varying recovery intervals on multiple-bout, short-duration, high-intensity cycling efforts of adult men supplemented with creatine or a placebo. Creatine was taken in daily dosages at the rate of 0.3 grams per kilogram of body weight per day for 7 days. When compared to the placebo group the subjects taking creatine improved recovery time from repeated sprint cycling when recovery intervals were short in duration, less than 6 minutes. Exercise testing consisted of 8, 15-second bouts of sprint cycling exercise.

Creatine and Hockey Players Performance


This research study examined the effects of creatine monohydrate supplementation on multiple sprint cycle and skating performance in ice-hockey players. Sixteen elite ice-hockey players were selected as subjects, and the subjects were randomly assigned to either a creatine group (8 males) or a placebo group (8 males) in a double blind design. Subjects loaded with 5 grams of creatine monohydrate or placebo (glucose) four times per day for 5 days, (20 grams per day). After this loading period a maintenance dose of 5 grams per day for 10 weeks was administered. At the beginning of the study and after 10 days and 10 weeks of supplementation, subjects performed a cycle test involving 5 all-out sprints of 15 seconds duration separated by 15 seconds recovery with the resistance set at 0.075 body mass kilograms; and the performed 6 timed 80-meter skating sprints with the sprints initiated every 30 seconds and a split time taken at 47 meters. No significant change in any of the tests in the placebo group over the period of study. However, in the creatine group significant results were observed as follows:

- In the creatine group, average mean power output over the 5 sprints was significantly higher at 10 days, 1074 Watts, and 10 weeks, 1025 Watts than at the beginning of the study, 890 Watts.
- Average peak power output over the 5 sprints improved significantly from the beginning of the study, 1294 Watts, to 10 days, 1572 Watts.
- Average on-ice sprint performance was significantly faster at 10 days, 6.88 seconds, and at 10 weeks, 6.96 seconds, when compared to the beginning of the study, 7.17 seconds.

The results of this study clearly demonstrate that creatine supplementation has an ergogenic effect in elite ice-hockey players.
Creatine And Improved Sprint Running Performance


The purpose of this research study was to evaluate the effect of creatine monohydrate supplementation in well trained male sprinters. The study was performed as a single blind test on 18 sprinters. The participants consumed either, 20 grams creatine and 20 grams glucose per day (9 males), or 40 grams of glucose per day the placebo group (9 males), divided into 4 equal daily dosages. The effect of creatine on sprint performance was evaluated in two tests, 1 x 100 meters sprint and an intermittent 6 x 60 meter sprint test. The researchers determined the following effects of creatine supplementation:

- Increased the 100 meter sprint velocity; 11.68 seconds versus 11.59 seconds.
- Reduced the total time of 6 intermittent 60 m sprints; 45.6 seconds versus 45.1 seconds, whereas no changes were observed in the placebo group.
- The sprint velocity was significantly increased in 5 out of 6 intermittent 60 meter sprints.

The researchers noted that the improved sprint performance suggests an increased availability of energy substrate for performing work, possibly as a result of increased skeletal muscle creatine phosphate.

Creatine and Handball Players Performance


This study examined the effects of creatine monohydrate supplementation on maximal strength, muscle power production during repetitive high-power-output exercise bouts (MRPB), repeated running sprints, and endurance in handball players. Creatine supplementation was 20 grams per day for 5 days. Nineteen trained male handball players participated in the study, 9 in the creatine group and 10 in the placebo group. The five days of creatine supplementation lead to significant improvements in some performance parameters, for example, in lower-body maximal strength, maximal repetitive upper-body and lower-body high-power exercise bouts, and total repetitions performed to fatigue in the repetition maximum set of high power output exercise bouts, as well as enhanced repeated sprint performance and attenuated decline in jumping ability. Creatine supplementation did not result in any improvement in upper-body maximal strength and in endurance running performance when compared to the results of the players taking the placebo.

Creatine and Squash Player Performance


The purpose of this research study was to determine the effects of oral creatine supplementation on high intensity, intermittent exercise performance in competitive squash players. Nine squash players performed an on-court “ghosting” routine that involved 10 sets of 2 repetitions of simulated positional play, each set interspersed with 30 seconds passive recovery. This study used a double blind, crossover design in which the creatine group supplemented 4 times daily for 5 days with 0.075 grams per kilogram of body mass of creatine monohydrate and the placebo group with the same amount of maltodextrin placebo. There was a 4 week washout period separated the crossover of treatments. The creatine supplement group improved:

- mean set sprint time by 3.2% over and above the changes noted for the placebo group.
- sets 2 to 10 were completed in a significantly shorter time following creatine supplementation compared when the player were taking the placebo.
The researchers concluded that their data support existing evidence that creatine supplementation improves high intensity, intermittent exercise performance. In addition, their study provides new evidence that oral creatine supplementation improves exercise performance in competitive squash players.

Creatine And Female Softball Player Performance


The purpose of this study was to determine the effects of creatine monohydrate supplementation on muscle strength and endurance of trained female softball players. Creatine was taken for 1 week at 20 grams per day, and for 2 weeks at 3 grams per day. The researchers concluded that the creatine taking athletes did not improve the maximal static strength and dynamic peak torque but they did improve the mean strength and endurance of repeated contractions. Also, the effects on females are not so great as that found in males. Additionally, it was determined that the effects of taking creatine are enhanced by anaerobic exercises performed before the supplementation and the effects would disappear in a week when the supplementation was stopped.

Creatine And Military Personnel Performance


These military researchers noted that dietary creatine monohydrate supplementation has been shown to enhance muscular strength and endurance. In this study they wanted to determine the effects of creatine supplementation on performance of military training tasks. Two groups of 13 male soldiers each were selected for the creatine taking group and placebo group. The soldiers performed 3 consecutive military obstacle course runs (approximately 3 minutes over 7 obstacles with a 2 minute rest between runs) followed by a rifle marksmanship task on 3 occasions each separated by 5 days. The soldiers also completed a bench press training program consisting of 5 sets to failure at 70% of 1 repetition maximum. They also answered the Profile of Mood States questionnaire during each test session. Testing was done 3 times. No supplementation was given before test 1. Creatine supplementation was provided using sports bars, with both groups receiving placebo bars between test 1 and test 2. From test 2 to test 3 the creatine group consumed 24 g per day of creatine monohydrate in sports bars and the placebo group consumed an equal amount creatine free calories in the placebo sports bars. Five days of creatine supplement ingestion resulted in a significant (14%) increase in total bench press repetitions, but no difference between groups in obstacle course run times for the 3 runs from test 2 to test 3. Marksmanship or mood was not affected by creatine supplementation. Regarding body mass, an increase of 1.4 kg in body mass and a 0.5% decrease in percent body fat were observed in the creatine group. These military researchers concluded that creatine supplementation over 5 days improved performance during a controlled strength test but did not significantly improve military obstacle course performance.
This group of military researchers wanted to determine the short-term effects of creatine monohydrate supplementation on performance of military tasks, thermoregulation, and health risks. Male military personnel were randomly assigned to a creatine group (8 males) or a placebo group (8 males). Testing was conducted at the beginning of the study and again after a 6-day loading phase (20 grams of creatine per day), and then again after 4 weeks of taking 6 grams of creatine per day. Measurements included body composition, liver/kidney function tests, core body temperatures during a 10-mile march and 5-mile run, and performance on physical tasks. Results of this military research study included:

- Serum and urine creatine increased significantly in the creatine group.
- Body mass increased significantly in the creatine group.
- Number of pull-ups performed increased significantly in the creatine group.
- However, there were no significant differences between the creatine and placebo groups for other performance measures, body composition, core body temperature, or other biochemical measures.

The military researchers also noted that the use of creatine did not cause acute health problems.

OTHER ERGOGENIC BENEFITS OF CREATINE

Creatine And Thermoregulatory Benefits


The effects of creatine monohydrate supplementation on cardiovascular, metabolic, and thermoregulatory responses, and on the capacity of trained humans to perform prolonged exercise in the heat, was examined in this research study. Twenty-one endurance-trained males performed 2 constant-load exercise tests to exhaustion at 63 VO2max in the heat (ambient temperature: 30.3 C) before and after 7 days of creatine supplementation (20 g creatine per day plus 140 g glucose polymer per day) or placebo drink. Creatine increased intracellular water and reduced thermoregulatory and cardiovascular responses, such as heart rate, rectal temperature, and sweat rate. Time to exhaustion was increased significantly in subjects whose estimated intramuscular creatine levels were substantially increased; responders, 47.3 minutes, versus 51.7 minutes. The researchers concluded that creatine induced hyper-hydration can result in a more efficient thermoregulatory response during prolonged exercise in the heat.

OTHER HEALTH BENEFITS OF CREATINE

Spinal Cord Injury


This study examined the effects of short-term creatine monohydrate supplementation on the upper extremity work capacity of persons with cervical-level spinal cord injury (SCI). The study was randomized,
double-blind, placebo-controlled, crossover design study, which consisted of 2 treatment phases lasting for 7 days, separated by a 21-day washout period. Sixteen men with complete cervical-level spinal cord injury, at C5-C7 participated in the study. Subjects were randomly assigned to 1 of 2 groups and received either 20 grams per day of creatine monohydrate supplement powder or placebo maltodextrin powder for the first treatment phase. Then the treatment was reversed in the second phase. The researchers determined that creatine supplementation enhances the exercise capacity in persons with complete cervical-level SCI and may promote greater exercise training benefits.

**Creative Supplementation And Improvements In Strength And Body Composition In People With Duchenne Muscular Dystrophy.**


This study was conducted to determine whether creatine monohydrate supplementation increases strength and fat-free mass in boys with Duchenne muscular dystrophy. The study recruited thirty boys with Duchenne disease. The study was a cross-over trial conducted over 4 months. Subjects ingested about 0.10 grams per kilogram of body weight per per day, followed by a 6-week wash-out, and 4 months of placebo. During the creatine treatment phase, there was an increase in handgrip strength in the dominant hand and an increase in fat-free body mass. There was a trend toward a loss of muscle placebo phase. The researchers concluded that four months of creatine monohydrate supplementation led to increases in fat-free mass and handgrip strength in the dominant hand and a reduction in a marker of bone breakdown and was well tolerated in children with Duchenne muscular dystrophy.

**Creatine Lowers Homocysteine Levels**


The objective of this study was to determine if oral creatine monohydrate supplements can lower the concentration of total plasma homocysteine. Healthy volunteers took multi-vitamins daily for four weeks, then were randomly divided into two groups. The control group continued to take multi-vitamins daily for an additional four weeks. The experimental group took multivitamins plus an amount of creatine each day equal to twice their daily creatinine excretion, for the additional four weeks. After four weeks of creatine supplements, homocysteine levels in the experimental group reduced significantly when compared to the control group; average of -0.9 micromol/L (range: -1.8 to 0.0) for the experimental group, compared to an average change of +0.2 micromol/L in C (range: -0.6 to 0.9) for the control group. The researchers concluded that creatine supplements may be an effective adjunct to vitamin supplements for lowering homocysteine. Take note that a high homocysteine blood level is a risk factor for cardiovascular diseases.

**Creatine and Insulin sensitivity**


This study investigated the effects of creatine supplementation on glucose tolerance or insulin action in healthy, untrained men, average age 26.9. The creatine group ingested 20 grams per day for the first five days, and 3 grams per day for 28 days, of creatine. The placebo group ingested glucose over the same time period. Creatine supplementation resulted in an increased muscle total creatine content compared with placebo. Creatine supplementation did not influence skeletal muscle glycogen content, glucose tolerance, or measures of insulin sensitivity. The results of this study demonstrated that short-term creatine supplementation did not alter insulin action in healthy, active untrained men.
This section presents an overview of the dosing regimens that were clinically validated to produce beneficial effects from ingestion of a creatine monohydrate containing supplement. Creatine monohydrate is the ingredient of choice based on the results of over 200 clinical studies that prove creatine monohydrate works best. Section 6 reviews some of the other creatine molecule complexes. However, there is currently no evidence that these other forms of creatine produce better results than creatine monohydrate. There is evidence that indicated combining creatine monohydrate with other substances may enhance creatine uptake in to the body, which will also be reviewed in this section. There is also the issue regarding the intake of caffeine with creatine, which the research will be reviewed in this section. This section will end with an overview of the safety issues regarding the use of creatine supplementation.

Even though there are numerous clinical studies conducted using creatine monohydrate supplementation, there are still some unanswered questions. As I indicated in the previous section, scientists sometimes get caught up in the “blind leading the blind” syndrome. As this related to creatine supplementation, most of the studies have followed a generalized creatine loading period, followed by a lower dosage maintenance period, while other studies have focused their attention on determining what the lowest effective daily dose of creatine that would product beneficial results. Most of the studies have focused on the pharmacological properties of taking creatine supplements; its effects on the body.

This leads me to a point, which is also underscored by researchers Adam Persky and Gayle Brazeau, from the University of Florida, College of Pharmacy, in their review paper titled “Clinical Pharmacology of the Dietary Supplement Creatine Monohydrate”. There is a future research need to fine-tune our understanding of the “pharmacokinetics” of creatine supplementation. While pharmacology is the general term that encompasses
the effects a substance produces in the human body, pharmacokinetics is the study of the bodily absorption, distribution, metabolism, and excretion of substances, in particular drugs, but the principle also applies to nutrients taken for health and athletic performance.

The main point I want to make regarding this lead-in to creatine dosing is that due to the fact that pharmacokinetics has not been clearly defined, there may be opportunity to refine the creatine dosing regimen based on future research and fine-tuning of the dynamics of creatine supplements in the human body. As you learned in Section 4, some of the research studies calculated the creatine dosages based on lean body mass, or body weight. But, the dosages were based on either lean body mass or body weight, meaning that there is no clearly established body weight based dosage method. This body weight dosing approach is an interesting trend, but far from being finalized or confirmed. With this in mind, the following dosage information is based on the results of the majority of research studies reporting beneficial effects of creatine supplementation. This information is for healthy adults, and creatine and other supplement use is best accomplished under doctor supervision, as this or any publication is not intended to replace medical advice or medical supervision.
**CREATINE DOSING GUIDE SUMMARY**

Use under medical supervision for safe and effective results. For health individuals only, who are engaged in strength training, muscle building and strength sport training and competition season.

**Preferred Creatine Type:** Creatine Monohydrate powder or chewable tablets.

Use only high quality research grade / pharmaceutical grade creatine, which are guaranteed free from impurities, such as dicyandiamide, dihydrotriazine, and creatinine. (note: quality results require a quality product).

<table>
<thead>
<tr>
<th>Creatine Dosing: Loading Phase (based on ideal body weight.)</th>
<th>Duration of Use: 7 days.</th>
<th>20 grams per day, less than 200 pounds ideal body weight</th>
<th>Ingest in 4 to 6 divided dosages each day.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>25 grams per day, 200 pounds to 300 pounds ideal body weight</td>
<td>Take 60 to 30 minutes before meals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 grams per day, over 300 pounds ideal body weight</td>
<td>Or take with meals if gastrointestinal upset is experienced.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If gastrointestinal upset persists, reduce the daily dosage to the maintenance dose regimen, realizing that it will take a few weeks longer to achieve increased creatine body levels that will results in the desired benefits.</td>
</tr>
</tbody>
</table>

Optional. Consumption of a glucose beverage 30 minutes after creatine consumption.

Can also take a creatine combination product that includes glucose, protein, amino acids, vitamins, minerals, and other sports nutrition ingredients.

Avoid mixing acidic beverages with creatine.

<table>
<thead>
<tr>
<th>Creatine Dosing: Maintenance Phase (based on ideal body weight.)</th>
<th>Duration of Use: up to 4 months. Followed by 4 or more weeks of non-creatinie use. Then repeat loading/maintenance regimen as required by your training and competition schedule</th>
<th>5 grams per day, less than 200 pounds ideal body weight</th>
<th>Ingest in 1 to 2 divided dosages each day.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7 grams per day, 200 pounds to 300 pounds ideal body weight</td>
<td>Take 60 to 30 minutes before meals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 grams per day, over 300 pounds ideal body weight</td>
<td>Or take with meals if gastrointestinal upset is experienced.</td>
</tr>
</tbody>
</table>

Can also take a creatine combination product that includes glucose, protein, amino acids, vitamins, minerals, and other sports nutrition ingredients.

Avoid mixing acidic beverages with creatine.

**Note:** taking creatine with whey protein supplements can significantly improve the benefits. Use a product that contains whey protein isolate for best results.

Keep a high quality container of pure creatine in your supplement cabinet to use for loading and maintenance and if you want to increase the creatine content of your protein powder.

**Preparation:** the best preparation method is dissolving creatine monohydrate powder in to water.

Pure creatine monohydrate has a solubility of about 7 to 8 grams in 500 ml of water. Warmer water can dissolve more creatine per ml or water. Consume your creatine solution after mixing the powder into solution. High quality creatine should easily dissolve. A poor dissolving creatine product is a sign that it might not be high quality.

Creatine monohydrate can be taken with other supplements, such as vitamins and minerals, protein powders, etc, or as part of a complex supplement formula where creatine monohydrate is one of the ingredients. The most important factor to taking creatine is to be consistent and take it on a regular basis. It takes several days for the muscle cells to increase total creatine and creatine phosphate levels, and using the maintenance dose every day keeps the muscle tissue levels saturated.

Avoid continuous and high caffeine consumption while taking creatine supplements. Also avoid or minimize alcohol consumption during training and competition seasons. Alcohol consumption interferes with protein synthesis, and also promotes dehydration, and cellular damage.
CREATINE PLUS OTHER INGREDIENTS

Some research studies have examined the effects of combining creatine with other nutrients to determine if creatine uptake is enhanced or if there is a synergistic effect. The following is a review of some of the recent research regarding combining creatine with other nutrients, including protein, carbohydrates, glutamine, magnesium and alpha-lipoic acid. A summary of this topic is found after the research reviews of this subsection.

Effects of Creatine Monohydrate Plus Whey Protein


The purpose of this research study was to measure muscular developments during 6 weeks of resistance training, among 36 males who were randomly assigned to supplementation with whey protein, whey protein and creatine monohydrate, or a placebo (maltodextrin). At the end of the 6 week study period the following results were observed:

- Lean body tissue mass increased to a greater extent in the whey-creatine group compared to the other groups; and also in the whey group when just compared to the placebo group: +4 kg, 6.5% in the whey-creatine group; +2.3 kg, 3.8% in the whey group; and +0.9 kg, 1.5% in the placebo group.
- Bench press strength increased to a greater extent in the whey-creatine group compared to the other groups: +15.2 kg, 17% in the whey-creatine group; 6.3 kg, 7% in the whey group; and 7.2 kg, 8% in the placebo group.
- Knee extension peak torque increased significantly with training in the whey-creatine and whey groups, but not for the placebo group.

It was also observed that continued training for an additional 6 weeks without supplementation resulted in maintenance of strength and lean tissue mass in all groups. The results of this study revealed a synergistic effect among males taking the whey protein and creatine supplement, which resulted in greater increases in lean tissue mass and bench press performance.

Creatine and Protein Supplementation


This study was undertaken to determine the effects of creatine monohydrate and creatine plus protein supplementation on GLUT-4 and glycogen content of human skeletal muscle. Note that GLUT stands for glucose transporter. There are 5 main GLUTs which tend to be tissue specific, and GLUT-4 is more abundant in skeletal muscle tissue and also adipose tissue. This double-blind, placebo-controlled trial was performed on 33 young healthy subjects (26 men and 7 women). The subjects' right legs were immobilized with a cast for 2 wk, followed by a 6-wk resistance training program for the right knee extensor muscles. The participants were supplemented throughout the study with either placebo (maltodextrin) or creatine & maltodextrine, or with creatine plus protein during immobilization and creatine plus protein, maltodextrine, amino acid blend, and multivitamin blend during retraining. Needle
biopsies were bilaterally taken from the vastus lateralis. GLUT-4 protein expression was reduced by the immobilization in all groups. During retraining, GLUT-4 content increased in both creatine (+24%) and creatine-protein (+33%) groups, which resulted in higher post training GLUT-4 expression. Compared with the placebo group, the muscle glycogen content was higher in the trained leg in both creatine and creatine-protein groups. Supplements had no effect on GLUT-4 expression or glycogen content in contralateral control legs. Area under the glucose curve during the oral glucose tolerance test was decreased from 232 mmol. per liter per minute at baseline to 170mmol. per liter per minute at the end of the retraining period in creatine-protein group, but it did not change in the creatine or placebo groups. The researchers concluded that creatine intake stimulates GLUT-4 and glycogen content in human muscle only when combined with changes in activity level, and that combined protein and creatine supplementation improved oral glucose tolerance.

Creatine Monohydrate and Alpha-lipoic Acid


The purpose of this study was to determine the effect of alpha-lipoic acid on human skeletal muscle creatine monohydrate uptake by directly measuring intramuscular concentrations of creatine, phosphocreatine, and adenosine triphosphate when creatine monohydrate was co-ingested with alpha-lipoic acid. Muscle biopsies were acquired from the vastus lateralis (a muscle of the upper leg) of 16 male subjects age range from 18 to 32 years. After the initial biopsy, subjects ingested 20 grams per day of creatine monohydrate, 20 grams per day of creatine monohydrate plus 100 grams per day of sucrose, or 20 grams per day of creatine monohydrate plus 100 grams per day of sucrose plus 1000 milligrams per day of alpha-lipoic acid for 5 days. Body weight increased by 2.1% following the supplement taking, with no differences between the groups. There was a significant increase in total creatine concentration following creatine supplementation, with the group ingesting alpha-lipoic acid showing a significantly greater increase in phosphocreatine.

However, as I previously mentioned, most of the studies using glucose or other carbs in association with creatine loading do not measure outcomes, for example, increases in lean body mass, increases in strength, or increases in athletic performance. The outcome in increasing body weight was the same for all of the groups in this study, so creatine monohydrate worked just as good as the other combination dosages for increasing body weight. Additionally, 1000 milligrams of lipoic acid is very expensive, and as the previous studies demonstrated, combining creatine with whey protein, produces significant and quite impressive results in increased lean body mass and strength.

Magnesium and Creatine


This study evaluated magnesium-creatine supplementation on body water and quadriceps torque. The following supplements were used in this study, in three different groups of subjects: Maltodextrin as the placebo; Magnesium oxide plus Creatine monohydrate, at 800 mg magnesium and 5 grams creatine per day for 2 weeks; Magnesium-creatine chelate, at 800 mg magnesium and 5 grams creatine per day for 2 weeks. Body weights of the subjects increased for both of the magnesium – creatine treatment groups; average increase of 0.75 kilograms in the magnesium oxide – creatine group, and 0.4 kilograms in the magnesium-creatine chelate group. Both treatment groups had increased power. However, these increases were not greater then taking creatine monohydrate alone, when compared to other studies conducted using creatine monohydrate.
Creatine and Glutamine


This study used twenty-nine athletes, 17 men and 12 women, who were collegiate track and field athletes. Ten were randomly assigned to take creatine monohydrate, ten to take creatine monohydrate and glutamine, and nine to take a placebo. The creatine monohydrate taking group received 0.3 grams creatine per kilogram of body mass per day for 1 week, followed by 0.03 g creatine per kilogram of body mass per day for 7 weeks. The creatine monohydrate – glutamine taking group received the same creatine dosage scheme as the creatine monohydrate taking group plus 4 grams of glutamine per day. All 3 treatment groups participated in the same strength and conditioning program during preseason training. Measurements observed during the study included body composition, vertical jump, and cycle performances before and after the 8-week supplementation period. After the study period it was determined that body mass and lean body mass increased at a greater rate for the creatine monohydrate and creatine monohydrate – glutamine taking groups, compared with the placebo treatment. Additionally, the creatine monohydrate and creatine monohydrate – glutamine taking groups exhibited significantly greater improvement in initial rate of power production, compared with the placebo treatment. These results provide evidence that the creatine monohydrate, with or without glutamine produces significant benefits.

Creatine And Carbohydrates

This subsection deserves some overview commentary, as the research study designs are too cumbersome to present in a way that can be easily understood. To begin, the two 1996 studies that first examined the effects of taking creatine and glucose together were conducted using people who were not strength training. In the 2003 study headed by D. Preen, the same study design was used, one in which the creatine + glucose subjects did not undergo a strength training program. These studies also do not report significant outcomes that have been previously reported for taking creatine alone, such as increases and strength or athletic performance, as the subjects were not required to exercise during the study period. With one exception, the 2003 study included a group that took creatine and an under went a 60 minute session of cycling exercise each of the 5 creatine loading days.

The overall results indicate that taking creatine alone will result in significant increases in total body creatine and phosphocreatine, but that taking creatine with glucose resulted in achieving higher levels during the loading phase. During the maintenance phase, only creatine was ingested, without the ingestion of a glucose drink. In the 1996 studies
subjects ingested 20 grams of creatine a day, and 370 grams of glucose per day, in 4 divided dosages. In the 2003 study, on average 144.6 grams of glucose was consumed per day, with the 20 grams of creatine. The glucose beverage was actually consumed 30 minutes after the subjects ingested the creatine solution. Based on the total body of research, creatine monohydrate taken alone is effective. During the loading phase, creatine plus glucose may result in higher levels of creatine and phosphocreatine, under conditions of not exercising. However, more research is needed to compare the effects of creatine versus creatine + glucose loading, while the subjects are undergoing strength training, and comparing the effects on athletic performance. So, it is optional to take creatine with glucose or other carbohydrates, especially if you take creatine 30 to 60 minutes before a meal, as your meal will provide insulin stimulating nutrients.


This study examined the effects of supplementation with either creatine monohydrate powder prepared in solution versus a commercially available creatine liquid. The performance test was a repeated maximal sprint cycling test; 10 x 6 seconds, 24-second passive rest between sprints. This study used a randomized, double-blind, crossover design. Eleven competitive male athletes supplemented with creatine. The 2 supplementation programs they followed were 1) twenty grams per day for 6 days of creatine powder prepared in solution, or 2) five milliliters per day for 6 days of creatine serum product. The results showed that the subjects' taking the creatine powder in solution had an increase in total work (9.6%) and peak power (3.4%) in the cycle sprint. However, there was little change after using the creatine serum supplement. The results of this study reconfirmed that creatine monohydrate powder can produce an ergogenic effect. The researchers noted that the creatine serum may have been ineffective because there is a substantial conversion of creatine into creatinine when in solution for long periods of time, and that the creatine serum product probably had little creatine remaining in it, versus the freshly prepared drink made using creatine powder.
This study illustrates an important point regarding the stability of creatine in solution. When creatine is mixed with water, or other fluids, some of the creatine will eventually start to convert to creatinine. It usually takes a few to several hours for this to start to happen. The rate of this creatine to creatinine conversion is increased as the pH of the liquid is decreased, more acidic fluids. Creatine beverages, made from creatine powder should be consumed with in an hour of mixing the creatine powder in the fluid, to ensure that you will be ingesting 100% creatine. You should also avoid mixing creatine with acidic beverages. However, if you need to premix your creatine, you can greatly slow down the conversions of creatine to creatinine by refrigerating your creatine beverage.

**Creatine Powder, Creatine Lozenge And Creatine From Meat Absorption Comparisons**

**Harris RC, Nevill M, Harris DB, Fallowfield JL, Bogdanis GC, Wise JA. Absorption of creatine supplied as a drink, in meat or in solid form.**

The researchers in this study examined the plasma concentration over 6 hours after the ingestion of 2 grams of creatine (equivalent to 2.3 grams creatine monohydrate) contained in meat, creatine lozenge (crushed in the mouth and swallowed) or in creatine monohydrate supplement prepared with water in five non-users of creatine supplements. The creatine supplement powder prepared with water resulted in a significantly more rapid and higher plasma creatine concentration then from the meat or creatine lozenge. Despite a possibly lower bioavailability, 2.3 grams of creatine monohydrate supplied in either solid form was nonetheless sufficient to raise the plasma concentration five- to six-fold in individuals with a mean body mass of 75.6 kg. Also note that one of the military studies reviewed in Section 4, used creatine in the form of a nutrition bar. This offers the creatine taker an alternative to having to prepare creatine beverages.

**Creatine And Caffeine**

The research regarding caffeine and creatine also deserves some discussion in light of the research findings. When the 1996 study was conducted, see study reference below, the researchers actually thought that caffeine ingestion might enhance creatine uptake. During the 1996 study creatine and phosphocreatine levels increased in both dosage regimens; creatine, and creatine plus caffeine. However, only the creatine group experienced an improvement in muscle strength performance. In both the 1996 and 2002 studies, caffeine intake was very high for a 3 day period, 5 mg per kg of body weight, about 350 mg per day of caffeine intake.

In these and other studies, caffeine intake has been shown to increase the muscle resting time during the muscle contraction cycle. Creatine actually decreases the muscle resting time, which is beneficial for strength athletes as this speeds-up the muscles. During fast repetitive muscle contractions shorting of the muscle resting time from a previous contraction is critical to maximum force output during the next muscle contraction. Also,
shorting muscle testing time may increase the number of actin-myosin activation cycles per unit of time and increase muscle power output.

My general recommendations regarding caffeine consumption for strength athletes is to minimize and avoid caffeine intake during periods of training and competition. Ingest caffeine sparingly, only periodically, for one day at a time, with a few days in between the next ingestion. The aforementioned studies measured the effects of a single day of ingesting caffeine (referred to as acute caffeine intake), which did not adversely effect muscle strength performance; however, it did not improve performance significantly. While we are on this subject, alcohol consumption also undermines your muscle building efforts. It actually interferes with protein synthesis. So during those important training and athletic season periods, it is best to avoid caffeine and alcohol intake. The thrill of competition should give you enough of a high.

As an aside, moderate caffeine use by endurance athletes has been shown to improve their performance significantly in most studies. Although, caffeine misuse and over consumption is counter productive. Additionally, some sports governing organizations have limits on the levels of caffeine permitted. Check with your organization to make sure you don’t get disqualified from being a caffeine drinker.


Creatine Safety

As indicated in the Kreider study referenced in Section 2, and in all of the studies reviewed herein, it turns out that under the conditions of these studies, creatine is proven to be both safe and effective. The reports of creatine causing cramps, are unproven. In fact, the most recent research reports the opposite; creatine use by athletes actually reduces the incidence and duration of muscle cramps. However, even though studies range up to 3 years in length of continuous creatine monohydrate supplement use, there
are still unanswered questions regarding all of the potential effects that long-term creatine use may have. So to be on the safe side it is use to plan creatine use during periods of intensive training and during the athlete season, so continuous use lasts up to 4 months in length. Then, abstain from creatine for 4 weeks or more. When you repeat use, follow the standard creatine loading, and maintenance regimen, as after 4 weeks, your body returns to near pre-creatine use levels. Creatine supplements should not be used by anyone who has any disease or disorder, without being under strict doctor supervision. People with a history of renal dysfunction or diabetes should avoid creatine supplementation.

In 2003, the results of another study performed using football players also reported no side effects from taking creatine monohydrate supplements. Greenwood, Kreider, Greenwood and Byars recorded the results of Division IA collegiate football players over a 4 month period that included training sessions, practices, and competition. The creatine taking group of football players loaded with creatine monohydrate for 5 days (0.3 g/kg body weight), and during the 115 day maintenance period consumed creatine at the rate of 0.003 g/kg of body weight). At the end of the is study period the researchers reported that creatine users experienced a reduced incidence of the following when compared to the placebo group: reduced rate of cramping, reduced heat/dehydration, reduced muscle tightness, reduced muscle strains, reduced non-contact injuries, reduced illness, reduced number of missed practices and reduced number of players lost for the season.


This section presents a quick overview at the research studies published, or lack of research studies published using other forms of creatine. You may be wondering why companies would go through the trouble and expense to reinvent something that already works so well; creatine monohydrate. One school of thought is that by connecting a different molecule to creatine, it may get in the body at a faster rate, and increase total creatine and phosphocreatine levels greater than creatine monohydrate.

The big question we all want to know the answer too, putting all of the marketing hype aside, is has anyone actually invented a better form of creatine?

At the writing of this 2005 edition there was no scientific evidence that other forms of creatine work better than creatine monohydrate. This includes the popular creatine ethyl ester HCl (CEE).

As it turns out, there is not any existing published research conducted with humans using CEE. Based on data submitted to the FDA by a CEE raw material manufacturer, the FDA noted that according to the rat study, the CEE dissociated in to creatine and ethanol in the gut before being bioavailable to the tissues. The FDA also noted that the rat study data did not show an increase in creatine blood levels in the rats that ingested the CEE. The FDA stated that the study failed to provide data showing that creatine levels were increasing as CEE dissociates and diffuses from the gut into the blood. This study did not clearly demonstrate the relative concentration of CEE, creatine, and ethanol between the gut and blood especially during the first three hours after intake. It is unclear to FDA how
creatine/creatinine levels in the urine could be detected yet there were no recorded measurements for creatine in the blood during the first 190 minutes of the experiment.

In all fairness to the CEE company, perhaps CEE is not as bioavailable in rats as it might be in humans. However, in this regard it is interesting to note that in the CEE patent, the illustration identifies CEE as “biologically inactive”, then shows some illustrations of what happens to CEE as it moves through the digestive system, where in the intestines the CEE has to be broken down by intestinal enzymes (esterases), and freed in to creatine monohydrate before it can be taken up in to the blood stream and delivered to the muscles. So, putting all of the marketing hype aside, there is currently no scientific evidence that CEE works better than creatine monohydrate.

Perhaps in the future there will be some humans studies conducted using CEE to determine if it is safe and effective in humans, and if effective, how it actually compares to the beneficial effects of creatine monohydrate, which I look forward to report about in future editions of this e-book.

**Creatine-Pyruvate And Cycling Performance**

The following study sought to see if there were any benefits of taking creatine-pyruvate.


This double-blind study was performed to evaluate the effects of creatine-pyruvate supplementation on exercise performance in well-trained cyclists. Seven athletes took 3.5grams of creatine-pyruvate twice a day for one week, and seven other athletes took a placebo. It was concluded that one week of creatine-pyruvate supplementation at a rate of 7 grams per day did not beneficially impact on either endurance capacity or intermittent sprint performance in cyclists.

Other forms of creatine, such as magnesium-creatine chelate, creatine citrate, and creatine phosphate, have not been shown to perform better then creatine monohydrate. In the case of using creatine compounds with minerals attached to the creatine, such as magnesium
or phosphate, there may be a concern of overdosing these minerals. Creatine intake requirement is high, especially during the loading phase, which may result in too high an intake of these minerals.

In summary, based on the available research, for best results, Creatine monohydrate has the most research backing its safety and effectiveness.
Appendix

RG-Creatine™

Explosive Growth Blend™
Sports Nutrition Pharmacy™

ANDRO-SHOCK™
Clinically Proven To:
Increase Muscle Mass
Increase Strength
Increase Athletic Performance
And More …

RG-Creatine Monohydrate (Research Grade)
100% Pure
Independently Lab Tested

Visit http://www.trulyhuge.com/rgcreatine.htm for over 50% discount special offer on this high quality creatine monohydrate powder.

To ensure you are purchasing the best quality product, Sports Nutrition Pharmacy™ RG-Creatine™ is made by following FDA authorized Good Manufacturing Practices (GMP).

This product is also tested to verify purity and that it meets Research Grade™ standards.

Research Grade™ -Creatine has been clinically proven to help:

- Promote greater gains for increasing FFM (Fat Free Mass, which includes muscle mass).
- Increase muscle fiber size; hypertrophy.
- Increase muscle mass.
- Increase myosin.
- Improve maximal strength.
- Improve maximal power.
- Improve single-effort sprint performance.
- Improve worked performed during repetitive sprint performance.
- Improve performance during exercise of high to maximal intensity.
The Number One Muscle Building Product You Can’t Live Without

Explosive Growth Blend is not for everybody. It is only for adult men, who what to gain 15 or more pounds of lean muscle mass fast and drug free. EGB is for muscle building men who are at the intermediate to advanced level of resistance training. Explosive Growth Blend is also for competitive strength athletes, who will definitely improve their performance; measurable results in just one week. So if you are serious about gaining maximum muscle fast, increasing your strength, increasing your size, and improving your definition in weeks, then Explosive Growth Blend is for you.

Build Massive Muscles! Get the PUMP, and MORE!

Increase your muscle growth rate!
Prime your anabolic matrix to maximize the anabolic cascade and mTOR protein synthesis pathways. Undeniably the most potent product ever developed. Get More Muscle Fast with the Revolutionary Scientifically Advanced Formula: Explosive Growth Blend from SPORTS NUTRITION PHARMACY™:

EXPLOSIVE GROWTH BLEND™
A new class of Super-Anabolics.


Be part of the new generation of elite champions. Customized by the Sports Nutrition Pharmacy, using SynerBlend™ technology.

Scientifically Engineered to Build Muscle Fast

EGB is the most super-anabolic product ever created. Guaranteed to increase your rate of muscle building and fat loss, simultaneously.

-Increases GH, IGF, Testosterone, Insulin, and other anabolic hormones.
-Elevates Nitric Oxide levels
- Includes ingredients for total body building effects, growth in muscle mass, connective tissues, and bones.
- Nervous system activators.
- Potent fat burners like CLA, ALC and Carnitine; plus, thermogenic boosters.
- Contains RG-Creatine, research grade.
- Highest quality Whey Protein Isolate.
- Energy stimulators.
- Research Grade ingredients; pharmaceutical quality; clinically verified dosages; manufactured under FDA GMP quality procedures.
- Increase rate of recovery too.

Explosive Growth Blend is for people who want to:
Grow muscle like crazy.
Get a body of steel.
Get huge as fast as possible.
Get stronger then ever before.
Sculp incredible definition.
Feed their muscles for maximum growth.
Build tremendous strength.
Attain massive size.
Get super-pumped, and experience Total Body Building Effects like never before possible.
Feel the Anabolic-Surge for yourself.

EXPLOSIVE GROWTH BLEND™ has it all.
Over $300 of potent muscle building power in each 6.3 pound jug.

Supplement Facts: Total Daily Serv Size: 225cc (134.5grams), Total Daily Servings: 21, Amount Per Daily Serving: Calories 357, Fat Cal 45, Total Fat 5g, Sat. Fat < 1g, Cholest. 4mg (1% DV), Sodium 49mg (2% DV), Calcium 31mg (4%DV), Total carb. 35g, Fiber < 1g, Sugars (from dextrose) 40g, Protein (from purified Whey Protein Isolate) 24g (48% DV).

Vitamin A (acetate) 2500 IU (50% DV), Vitamin C 30 mg (50% DV), Calcium 431mg (43% DV), Vitamin E 15IU (50% DV), Vitamin K 40mcg (50% DV), Thiamin 1.5mg (100% DV), Riboflavin 1.7mg 100% DV), Niacin 10mg (50% DV), Vitamin B6 2mg (100% DV), Folate 200mcg (50% DV), Biolin 100mcg (50% DV), Phosphorus 220mg (22% DV), Zinc (glucosinate) 7mg (47% DV), Selenium (methionine) 70mcg (100% DV), Copper (glucosinate) 2mg (100% DV), Manganese (glucosolate) 2mg (100% DV), Chromium (picoilate) 200mcg (133% DV), Molybdenum (amino acid chelate) 75mcg (100% DV)

Explosive Growth Blend™ Proprietary Anabolic Complex 65.6g: Amino Acid Blend [LeucinoBCAAPlex™ (Leucine, Isoleucine, Valine), GlutamiPlex™ (Glutamine & Glutamic Acid), ArginolRx™ (Arginine HCl & Arginine AKG), AminoBalancePlex™ (Alanine, Aspartic Acid, Cystine, Glycine, Histidine, Hydroxylysine, Hydroxyproline, Lysine, Methionine, Phenylalanine, Proline, Serine, Thaurine, Threonine, Tryptophan, Tyrosine)], RG-Creatine™ monohydrate, CLAPlex™ [Conjugated Linoleic Acid (c-9, t-11), Conjugated Linolein Acid (c-10, c-12), Linoleic Acid (c-9, c-12), & Oleic Acid (c-9) , Ornithine Alpha-keto-gluatrate (OKG), CarnitinolPlex™ (Acetyl-L-Carnitine (ACL) & L-Carnitine Fumarate), Glucosamine HCl, FlavanoidilComplex ™(Citrus Bioflavonoids & Green Tea Extract 50% polyhenols), Leci-PC 35 (35% phosphatidylycholine), Ferulic Acid, Silica.

EXPERIENCE THE POTENT MUSCLE BUILDING AND BODYBUILDING EFFECTS FOR YOURSELF.
ORDER EGB TODAY!

No other product comes close.

Notice: Explosive Growth Blend, SynerBlend, and Sports Nutrition Pharmacy are trademarks of Apironn Corporation
ANDRO-SHOCK

Andro-Shock is the most potent legal testosterone stack sold OTC as a safe alternative to steroids with 7 ingredients that are accepted worldwide as potential testosterone boosters.

The total benefits of this Andro Supplement are Synergistic, meaning when certain supplements are combined, their overall net effects are enhanced, allowing for explosive gains and muscle growth. Also, time-released capsules allow for consistently high plasma levels of testosterone without the lows which often occur when using similar products. Each dose contains:

- 100 mg. Tongkat Ali known as Long Jack, has been shown to support male hormonal balance (including testosterone availability), libido and performance. Tongkat Ali is a Southeast Asian botanical known to substantially increase testosterone levels (scientific abstracts note increased testosterone levels of up to 400%) and anabolic activity. Used traditionally to enhance energy levels, endurance and stamina, and to reduce occasional mental fatigue.

- 100 mg. DHEA - is a vital mother hormone manufactured by your adrenal glands. It is two steps away from Testosterone on the metabolic Pathway - meaning it converts to testosterone especially when your pituitary gland signals your body to increase production. It also can help to metabolize body fat.

- 100mg. Zinc Gluconate - Supplemental zinc in the male diet has long been known to increase and maintain high levels of testosterone in the body. When combined with the other supplements in this formula its effects are dramatically multiplied.

- 350 mg. Bulgarian Tribulus Terrestris - This supplement has been proven to increase levels of testosterone 30% by increasing production of Leutinizing Hormone(LH) which allows, the other herbs to work at their most efficient levels. It also helps to prevent the decrease of testosterone output from the testicles that often occurs with steroid use (similar to using HCG). This allows for the highest possible plasma testosterone levels with the least side effects.

Andro Shock has two of the most effective anti-estrogens available:

- 200 mg. Saw Palmetto- Helps to maintain plasma testosterone levels and elevate them indirectly by acting as an anti-estrogenic agent.

- 200 mg. Chrysin- The introduction of Chrysin into the supplement regimen can drastically decrease the body's estrogen production, and subsequently greatly reduce the possibility of negative side effects associated with excessive testosterone levels.

Three more things that make this Andro Stack stand alone are the additions of "A.M.U":

- Avena Sativa extract 100 mg.

- Mulra puoma extract 250 mg.

- Scientists have found that with age, testosterone becomes bound to various compounds within the body and "AMU" (Avena Sativa, Muira Puoma, and Urtica Dioica) can NATURALLY free this bound testosterone which ALREADY exists within the body. This results in a significant increase in athletic performance, lean muscle mass, strength, and sexual function.

FOR ORDERING INFORMATION Visit http://www.trulyhuge.com/andro-sh.htm
Want More Joint Power?

Glucosamine and Chondroitin Sulfate Supplements Are For Athletes Young and Old

By Daniel Gastelu

When I give lectures and talk about glucosamine and chondroitin sulfates (G&CS), most people are surprised to learn that these two natural substances are beneficial for both young and old people.

Popularized in the U.S.A. as treatments for osteoarthritis, the same reasons G&CS works for reducing the degradation of connective tissues in diseased joints, and other associated symptoms, such as pain, inflammation, stiffness, weakness, and poor flexibility, is why G&CS work to help everybody build a stronger body. These two substances are worth including in your daily supplement program, especially when undergoing periods of strenuous training and athletic competition, or for speeding up recovery from sports related injuries.

Benefits for Athletes are Actually Old News

In 1984 researchers in Frankfurt, Germany, brought to the attention of the world the benefits of glucosamine for healing knee problems in young athletes. A condition called chondropathia patellae is a common disorder of the knee in young athletes. The healing of this affliction must be rapid to avoid the development of future serious degenerative joint disease.

After taking a glucosamine supplement (1,500 mg per day for a few months) the teenage athletes quickly recovered, and returned to training. Reduction in knee pain was observed in just a few weeks. Furthermore, after a 12 month period of returning to training, researchers observed that the young athletes did not experience a recurrence of the knee problem.
The results of this landmark study clearly demonstrated the potent connective tissue repair, growth promoting and maintenance abilities of glucosamine supplements for athletes. Also, helping to prevent future joint problems, including development of osteoarthritis; this is all too common among athletes and the physically active.

**Research Reports More Benefits From Taking G&CS Supplements**

The most recent studies even show that taking G&CS supplements helps to reduce joint space narrowing due to connective tissue wear-and-tear, and can even prevent osteoarthritis from developing in the first place. Remember G&CS builds connective tissues, such as skin, tendons, ligaments, bone, and cartilage, which forms the matrix that is involved in holding your entire body together.

G&CS are made by the body similar to other metabolites, like creatine for example, but active people (especially athletes) create a demand for these substances that can be greater than the body can supply.

**What to do?**

Take supplements of G&CS to build and repair connective tissues faster and make them stronger.

This G&SC supply and demand problem is of special concern to all athletes who subject their body’s to overuse, also people whose work is physically demanding. (Aside: I keep bringing this up in my teachings, about people who are engaged in physically demanding work, because most physical labor jobs are many times more stressful, damaging and demanding on the body than athletic or bodybuilding training. In fact, physical laborers are actually “occupational athletes”, and need to follow a performance nutrition regimen for peak performance and maintenance of good health.) People engaged in progressive resistance training are especially susceptible to joint and connective tissue related injuries due to the constant wear and tear from the incredible force experienced by the joints that is created during high intensity training.

The benefits G&CS have to offer are obvious for anyone who is interested in building a stronger, better healthier body; preventing connective tissue & joint problems; and reducing the risk of...
developing arthritis. Some of the first studies regarding G&CS also found a beneficial effect on improving circulatory system function. When you think about how G&CS promote the growth of connective tissues, this makes perfect sense, as the circulatory system is made up of a high percentage of connective tissue.

**More Gains, Without Pain?**

Topping off the numerous benefits of taking a high quality G&CS supplement is the reduction of pain and inflammation. Conventional pain killers are common to athletes; non-steroidal anti-inflammatory drugs (NSAID) and steroidal drugs, for example. Surgery is commonly required to relieve the pain and inflammation due to athletic related connective tissue injuries.

But, the good news is that research reports taking G&CS supplements can reduce pain and inflammation, in some cases as good as ibuprofen, and without the side effects common to NSAID’s and steroidal drugs. A double bonus is that G&CS builds the body in the process of reducing pain and inflammation, making the best of both world’s possible. Note: most NSAID’s and steroidal drugs prescribed for pain have damaging effects on the body with long-term use, G&CS do not have these adverse effects.

Here is a summary of what some of the medical studies report about the numerous benefits people have experienced from taking high quality, research grade Glucosamine & Chondroitin Sulfate and why you should consider including a G&CS supplement in to your athletic nutrition program:

<table>
<thead>
<tr>
<th>SUMMARY OF GLUCOSAMINE &amp; CHONDROITIN SULFATE BENEFITS</th>
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<tbody>
<tr>
<td>➢ Improved wound healing</td>
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<td>➢ Faster recovery from injuries</td>
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<td>➢ Pain relief / reduction in pain levels</td>
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<tr>
<td>➢ Reduction in pain at rest</td>
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<tr>
<td>➢ Reduction in joint tenderness</td>
</tr>
<tr>
<td>➢ Reduction in joint swelling</td>
</tr>
<tr>
<td>➢ Improved physical performance</td>
</tr>
<tr>
<td>➢ Reduction in rubbing noises of the joints</td>
</tr>
<tr>
<td>➢ Increased flexibility / range of motion</td>
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<tr>
<td>➢ Inhibition of connective tissue degradation</td>
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<tr>
<td>➢ Stabilize joint space width</td>
</tr>
<tr>
<td>➢ Treatment of osteoarthritis</td>
</tr>
<tr>
<td>➢ Joint health improvements</td>
</tr>
<tr>
<td>➢ Enhanced synthesis of connective tissues</td>
</tr>
<tr>
<td>➢ Help reduce exercise related injuries</td>
</tr>
<tr>
<td>➢ Reduction in knee pain</td>
</tr>
<tr>
<td>➢ Slows tissue degradation</td>
</tr>
<tr>
<td>➢ Increases bone healing and repair</td>
</tr>
<tr>
<td>➢ Improves skin appearance</td>
</tr>
<tr>
<td>➢ Reduce skin wrinkles and fine lines</td>
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For muscle building athletes these benefits are outstanding. If you never tried taking G&CS supplements before, first time users will notice a very pronounced improvement in muscle growth rate, muscle density, and joint strength and function. You should also see improvements in other parts of your body, as G&CS support growth of all tissues. For example, improved skin appearance (including reduction in fine lines and wrinkles), reduction in the incidence and duration of injuries, faster recover from injuries, and overall improved body motion abilities, plus a reduction in pain and inflammation. Even stronger nails and thickening of hair (the shafts, not number of hairs) is commonly reported by G&CS users.

Some Technical Jargon
Glycosaminoglycans (GAG’s) is the technical term often used to describe the substances that comprise the category of connective tissues. Connective tissues by virtue of their physical and chemical characteristics are a gel-like matrix that forms the body’s ground substance. GAG’s function to stabilize & support tissues and cells. They also have a common property of holding water and being lubricating. In fact, as an aside, the lubricating properties of mucous secretions are due to GAG’s present in these fluids.

Inside the body, GAG’s function not only to hold everything together, but to also provide cushioning between tissues and structures, like bones connecting at joints, and also lubrication of the body parts and tissues, as well as helping to retain moisture in the body. Taking glucosamine and chondroitin sulfate supplements plays a vital role in the formation and maintenance of the body’s glycosaminoglycans.

Glycosaminoglycans consist of repeating units (chains) of smaller disaccharide units. Some of the major GAG’s and their disaccharide units are:

- **Chondroitin sulfates:** glucuronic acid & N-acetylgalactosamine
- **Dermatan sulfate:** iduronic acid & N-acetylgalactosamine
- **Keratan sulfate:** galactose & N-acetylglucosamine
- **Heparin:** glucuronic acid or iduronic acid & glucosamine
- **Hyaluronic acid:** glucuronic acid & N-acetylglucosamine
Glucosamine is part of most glycosaminoglycans as glucosamine or N-acetylglucosamine, and is used to make other GAG subunits, such as N-acetylgalactosamine. The point of this technical jargon review illustrates that G&CS work in many ways to stimulate, support production, maintenance and repair of the connective tissues in your body.

It may be news to some readers that glucose has a vital structural role in the body as a precursor of glucosamine and also glucuronic acid, in addition to its role as an energy producing nutrient. It is thought that the biochemical step that converts glucose to glucosamine, is the limiting step in connective tissue formation, and this is why taking glucosamine supplements helps to improve the rate of biosynthesis of connective tissues.

**Synergy**
Glucosamine and chondroitin sulfate have been extensively studied separately in clinical studies. Dozens of studies conducted around the world have concluded that these two substances indeed are effective on their own. However, from the above jargon, it is easy to understand how these natural substances can have additive effects when taken together, as they support the formation of many types of connective tissues in different ways.

Although it has become common practice to take G&CS supplement, it was not until the 21st century that researchers actually conducted studies to confirm this synergistic effect. Yes, research studies like the one conducted by Lippiello and coworkers in 2000, was the first to report that G&CS taken together produced greater results then glucosamine and chondroitin sulfate alone.

From Lippiello’s research it was also determined that in addition to the combination of G&CS having a synergistic effect on connective tissue growth, a connective tissue protective effect was also noted. It was observed that CS was effective in inhibiting enzymes, which breakdown connective tissues. So this connective tissue protective effect makes the benefits of taking C&CS even greater than previously thought.

As an aside, the National Institutes of Health is currently undertaking a massive multi-center research study to further determine the benefits of glucosamine and chondroitin sulfate. This NIH
study will compare the effects of taking a placebo or glucosamine or chondroitin sulfate or both G&CS, on people who have osteoarthritis of the knee. Referred to as GAIT (Glucosamine/Chondroitin Arthritis Intervention Trial), I’ll keep you posted on the results of this study, which are due out in 2005.

**Are the Effects of taking G&CS Lasting?**

From the research conducted with people who had osteoarthritis, the general observation was that improvements were seen starting in a few weeks, followed progressive improvements after 3 months, and so on. When people stopped taking G&CS, after several weeks the symptoms began to reappear. When G&CS supplements were taken again, the symptoms again improved.

Regarding healthy athletes with no apparent symptoms of connective tissue problems, there is currently no clear trend identified about what happens when G&CS is taken and then discontinued. The thinking among researchers is that taking G&CS supplements can help to build a stronger connective tissue matrix in the first place, to then help improve the way the body performs, and to prevent or reduce the occurrence of future injury and/or development of arthritis later in life.

So, the overall benefits of taking G&CS for athletic people of any age, especially if you are experiencing any joint pain or stiffness, include:

- Stronger muscle, bones, and connective tissues
- Improved joint lubrication
- Better hydration of all tissues
- Good cushioning and shock absorbing
- Increased joint strength and stability
- Reduction in connective tissue injuries or the severity of injuries
- Tougher and stronger skin, hair and nails
- Possible prevention of future development of osteoporosis, which is common among athletes
My Experience with G&CS

I started taking glucosamine in the early 1990’s when it first became available in the U.S.A. Within a few weeks my chronic knee pain was gone, and in a few months the pain in my shoulders disappeared. I also noticed that my muscles were stronger and felt denser. Eventually, I also experienced less delayed onset muscle soreness, and when it did occur, it was much less severe. I also experienced improvements in my hair, nails and skin, including better hydrated skin. More recently I also started taking G&CS together.

All told, I’m 100% satisfied with the results I have experienced from taking G&CS as part of my daily supplement program. I just wish this stuff was around when I started lifting weights in my youth. Back then, the consensus among weight lifters was that muscular strength and growth was faster than connective tissue growth. Therefore this was one of the reasons why most weight lifters would frequently experience connective tissue problems. Perhaps the new generation of weight lifters can avoid this by taking a G&CS supplement, in addition to pacing their progress to the entire body develops in harmony.

Who Should Take a G&CS Supplement?

For people who have osteoarthritis or joint pain, use G&CS under doctor supervision.

For athletes, use depends on the situation and what your budget permits. My standard recommendation is to not give up taking your daily multiple vitamin and mineral and protein supplements; these come first. So, assuming your budget permits, people who never used G&CS should try taking it for 6 months. This will help provide a connective tissue growth surge. Also, other times to include a G&CS supplement into your program is during periods of intensive training and athletic competition; when recovering from injury to improve the healing process; and if you feel aches and pains in your joints from the wear and tear of training. Always consult with your doctor to supervise your recovery from injury and to properly diagnose and treat signs of injury, which include aches and pains.
Taking G&CS for Best Results

The key to getting the same results reported in the scientific studies is to use a high quality, research grade G&CA supplement, at the proper daily dosage and for a proper duration to time. Taking glucosamine and CS separately works, and taking them together may work even better. The most effective dosages reported in the medical research studies is 1,500 mg Glucosamine and 1,200 mg Chondroitin sulfate per day, usually taken in divided dosages; total daily dosage divided over 2 or 3 smaller dosages; taken in the morning, (afternoon), and evening. Note that smaller dosages of Glucosamine and Chondroitin sulfate can be beneficial to help support connective tissue growth in a general way. But the higher dosages should be taken for first timer’s, and under the aforementioned circumstances of training or affliction.

While some results will be noticed in just weeks, it is best to take G&CS for several months at a time, and on going to prevent or manage existing problems. Studies have tracked the safe use of G&CS for three years, with no major side effects reported. Some times gastrointestinal upset may occur, which usually goes away on its own, or by taking the G&CS supplement with meals. Also, maintaining good hydration by drinking adequate amounts of water is always useful.

I recommend you only take a high quality research grade product, in capsule from, which will provide you with better results. Good quality glucosamine and chondroitin sulfate are expensive ingredients, especially CS. So, products with low retail prices usually indicates that cheaper ingredients were use to make them.

Purchase only a high quality G&CS product for best results, such as the Heathceuticals Healthiest Joints Adult Formula is available at

www.trulyhuge.com/healthiestjoints.htm

Visit there today for over a 30% discount on the Healthiest Joints formula.

See next page for more information about Healthiest Joints.
| The Healthceuticals brand of products is based on using research grade and research proven ingredients, in the dosages found to be clinically proven effective. | Healthceuticals™ Presents: 
Healthiest Joints™ 
Research Grade Ingredients 
Pharmaceutical Quality 
Glucosaminol™ & Chondroitinol™ |
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<tr>
<td>Healthceuticals products maintain such high quality standards, that they are packaged in pharmaceutical containers, and sold directly to the customer to maintain best quality, which translates in to best results.</td>
<td>For People Who Want the Healthiest Joints, Reduction Of Pain, and the Best Total Body Building Results</td>
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### What's in it?

<table>
<thead>
<tr>
<th>Supplement Facts:</th>
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<tbody>
<tr>
<td>Container Size: 90 Capsules</td>
</tr>
<tr>
<td>Daily Serving: 3 Capsules</td>
</tr>
<tr>
<td>Servings Per Container: 30 day supply</td>
</tr>
<tr>
<td>Amount Per Daily Serving: Healthiest Joints™ Proprietary Blend 2,700 mg (Glucosaminol™ (standardized Glucosamine HCl 1,500 mg) and Chondroitinol™ (standardized Chondroitin Sulfate 1,200 mg))</td>
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### The scientific research is clear, taking research grade Glucosaminol (standardized Glucosamine) & Chondroitinol (standardized Chondroitin Sulfate) at the proper dosages will result in building stronger and better connective tissues.

The research is also clear that athletic people put more wear and tear on the bodies, and need to include Healthiest Joints in to their daily supplement program, for best total body building results.

The Healthceuticals brand offers you the highest quality, most effective ingredients, in their clinically proven dosages and research grade form. This best quality formula means you will experience the best possible results you can.

Healthiest Joints is only available directly to you, and is not available in stores. This is to guarantee the best quality, at the best price.

Connective tissues are found throughout your entire body, and providing the building blocks means better strength and total body building results and improved athletic performance.

Key benefits of taking Healthiest Joints include:
- Promotion of joint function
- Better flexibility and ease of movement
- Maintenance of joint health and comfort
Maximizing production of joint lubrication fluids
Reduction in most joint pain
Increased tissue strength
Improved muscle to bone connective tissues
Increased anabolism and tissue growth (anabolic)
Reduction in tissue damage (anti-catabolic)
Improved wound healing, rejuvenating
Faster recovery from injuries
Pain relief / reduction in pain levels
Reduction in pain at rest
Reduction in joint tenderness
Reduction in joint swelling
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Stronger muscle, bones, and connective tissues
Improved joint lubrication
Better hydration of all tissues
Maintains good connective tissue cushioning and shock absorbing
Increased joint strength and stability
Reduction in connective tissue injuries or the severity of injuries
Tougher and stronger skin, hair and nails

Only the Healthiest Joints formula contains our proprietary, research grade, high quality ingredients, Glucosaminol and Chondroitinol. These research grade ingredients will produce fantastic results; you will feel start working fast. Typical users will start to feel their muscles getting denser, and their entire body getting stronger. Joint function also improves and gets better at handling the stress of being physically active.

In addition to the joint, bone and muscle benefits, most people also experience improvements in their hair, nails and skin, as these structures contain high amounts of connective tissues.

Experience the potent connective tissue and total body building results of taking this special research grade product yourself.

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