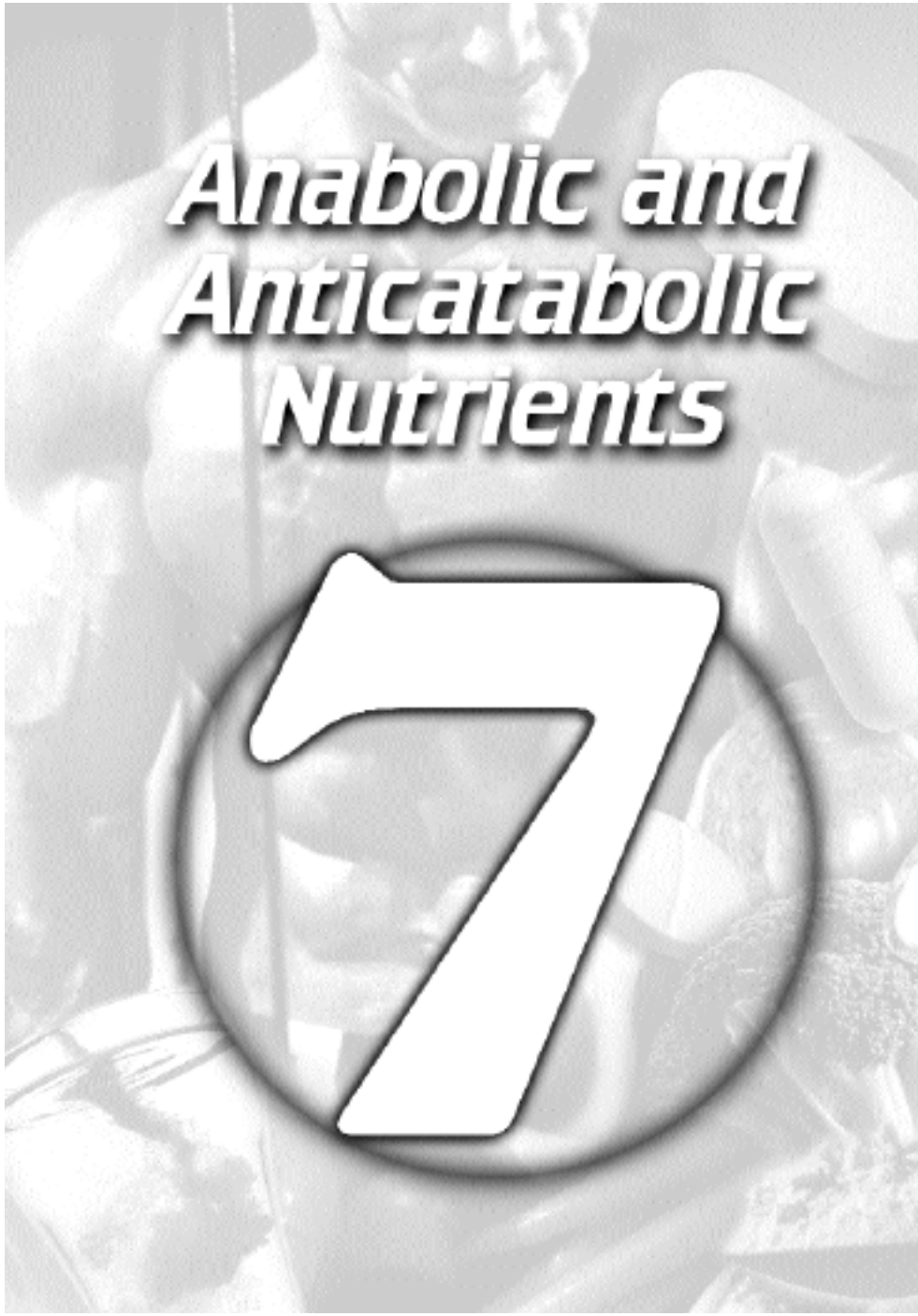
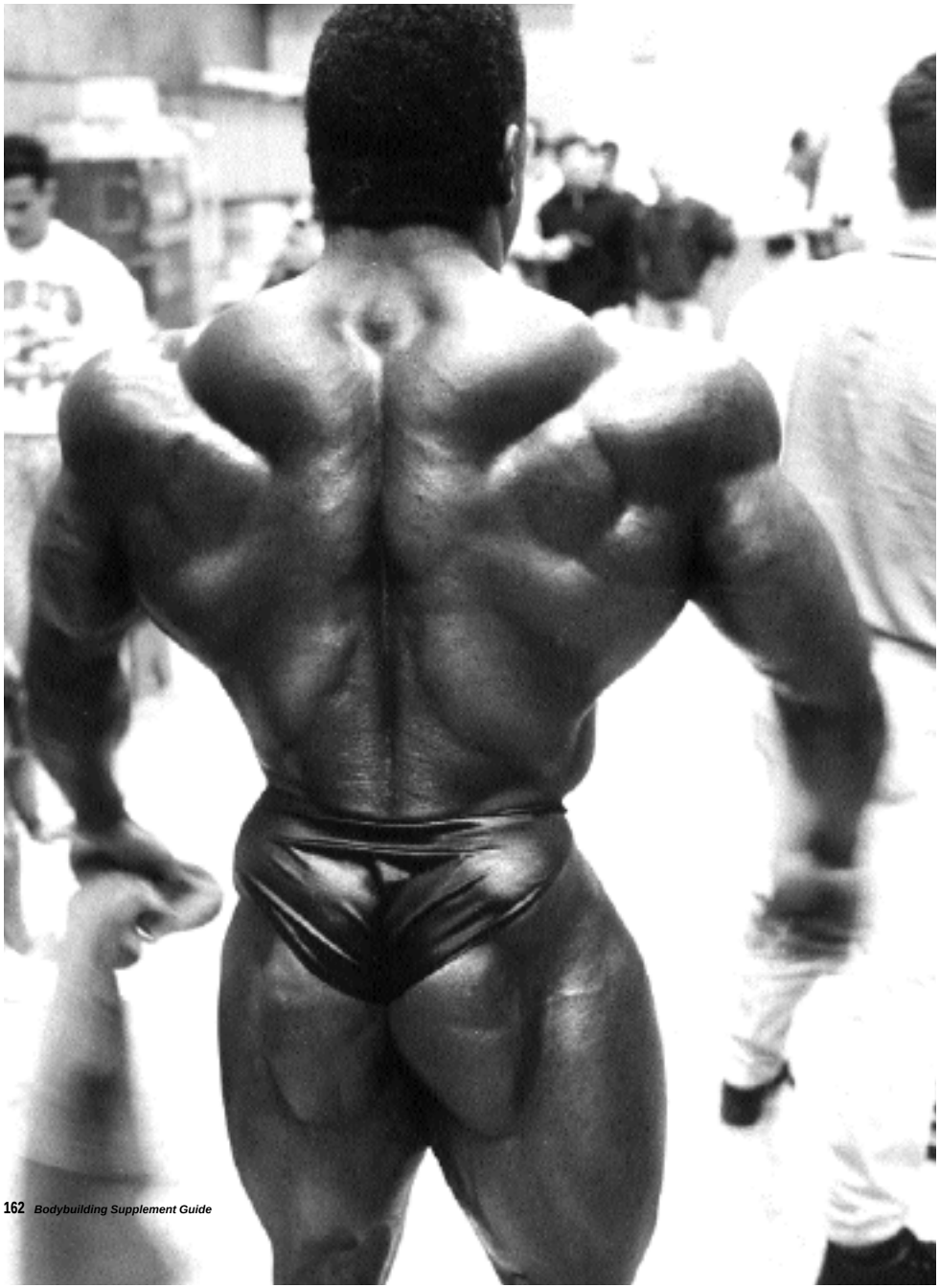

Anabolic and
Anticatabolic
Nutrients
7



Glutamine: The Essential Nonessential Amino Acid, Part 1

by Michael Gündill

Bodybuilders know about the importance of proteins. Yet it seems that some amino acids are more important than others in the muscle-building process. Glutamine has earned a reputation as king of the anabolic aminos—but is it justified? What's the big deal about glutamine, and how can you use it to your advantage?

Why Does Glutamine Stand Out?

Glutamine's importance is both quantitative and qualitative. Two-thirds of the free amino acids inside your muscles is glutamine. Muscles are not only a reservoir but also a major manufacturer. Most of the glutamine in your bloodstream is made in the muscles and organs, such as the liver. You can't get it directly from your meals, as it's digested and altered in the intestine. Many of the other amino acids, especially the branched-chain aminos (BCCAs), serve as precursors in glutamine synthesis.

Qualitatively, glutamine has a unique role in the muscle-building process. In the mid-'80s researchers discovered a very close relationship between free intramuscular glutamine levels and the protein synthesis rate. The higher the level of free glutamine inside your muscle, the faster the muscle grows. What's still unclear is whether the phenomenon is a cause or a consequence of anabolism: Is muscle growth accelerated because glutamine is high, or is glutamine upregulated to serve as raw material to support fast growth?

A popular hypothesis about the relationship between glutamine and growth is the muscle-swelling theory. Muscle anabolism can be accelerated by the swelling of the cells, which means water, ions and amino acids suddenly entering the cell, causing it to expand. The state of cellular hydration is supposed to influence its growth rate. The greater the hydration, the higher the protein synthesis rate. Cell shrinkage, on the other hand, is supposed to favor catabolism.

The relationship exists only if the swelling is not caused by cellular damage or trauma. Research has shown that the entry of glutamine into the muscle cell can increase its volume, inducing growth,[1] but cellular swelling can also accelerate the entry of glutamine into the muscle—which leaves us with the debate about whether it's the cause or the consequence.

Here are two key points to remember about glutamine:

•Glutamine makes up two-thirds of the muscle's free amino acid content.

•You should keep muscle glutamine as high as possible because it either induces or supports growth.

Integrins: The Mechanosensitive Molecules

A mechanosensitive molecule senses how much tension is applied to muscle cells in order to modulate their growth rate. If you remain inactive, lying in bed for days, your muscle mass shrinks because of a lack of tension. As you train, the muscle contractions cause a great strain on the cellular membranes, triggering growth. It's a fascinating process, one in which integrins are believed to play an important part.

Integrins are thought to be mechanosensors. They are chains that are hooked up to both the muscle cells and the extracellular matrix; that is, the very tough structure that holds all the muscle cells together. When a muscle cell is either flexed or swollen, great pressures are applied to the integrins, as they're forced to prevent the whole structure from bursting. In addition to their structural role, however, they're also regulatory receptors. In other words, integrins transduce, or convert, training-induced tension into chemical signals that re-

Glutamine makes up two-thirds of the muscle's free amino acid content, and you should keep muscle glutamine as high as possible because it either induces or supports growth.

sult in muscle growth.

It's interesting to note that whenever integrin functions are blocked, cell swelling cannot stimulate glutamine transport.[2] That points up the importance of integrins' role in the growth process whenever mechanical forces—like weight training—are the main stimulator. It also links glutamine not only to growth but also to the transduction of training-induced tension into anabolism. So, in theory at least, glutamine may be far more important for bodybuilders than was previously thought.

Is Glutamine Truly Anabolic?

It would be too easy if researchers could agree on the mechanisms by which glutamine is linked to growth. Some claim it's both anabolic and anticatabolic, while others can detect only an anabolic or a protective influence.

Darmaun and co-workers at a research center in Florida gave glutamine intravenously to healthy adults, and the results showed that anabolism was increased with no effect on catabolism.[3] Recently, he reported an experiment that's even more relevant for bodybuilders.[4] He used a chemical named phenylbutyrate to deplete glutamine in the blood by 26 percent, which translated into an estimated 11 percent decrease in the protein synthesis rate. No obvious change in catabolism was detected. Please keep those two figures in mind as you read the following.

Another group of scientists managed to increase the intramuscular content of glutamine in men, which resulted in an increased muscle protein synthesis. Those findings tend to show that glutamine is a direct growth mediator—although they could also mean that the anabolic drive is restricted because a relative shortage of glutamine represents a bottleneck.

Is Glutamine Anticatabolic at All?

According to the studies mentioned above, glutamine doesn't have much impact on catabolism; however, other researchers did detect that effect. Two factors are usually suspected of causing the discrepancies. One is the way in which protein turnover is measured. The other is the methodology used, meaning the time of day, method of glutamine administration, doses, subjects, etc. An experiment by Perriello, et al., in which fasting subjects were given glutamine intravenously, showed that above all, glutamine reduced catabolism.[5] The lesson for bodybuilders is that when you fast (at night, for example), the relative shortage of glutamine supply will increase muscle loss.

Here are two more points to remember:

•Glutamine is either anabolic or else a shortage of it impairs anabolism.

•Adequate glutamine supply may prevent catabolism.

Training-Induced Glutamine Deficit

Growing bodybuilders slowly build up their muscle glutamine stores, which can hide wide and dangerous short-term fluctuations. Each time you train, you deplete your glutamine reserves for several hours. That's a very unfortunate consequence of training, and you have to combat it.

Glutamine depletion follows a strange biphasic course. The first drop is the blood glutamine, and it occurs early in the workout. To make up for the deficit, your muscle starts manufacturing new glutamine from other amino acids, such as the BCAAs. That leads to the depletion of the other anabolic aminos. Eventually, the newly manufactured glutamine passes into the blood, which creates a shortage of muscle glutamine. If the glutamine manufacture is quick enough to compensate for the wasting of circulating glutamine, blood fluctuations may go undetected.[6] If the wasting is considerably stronger than the muscle manufacture, as frequently occurs during weight training, the drop in blood glutamine will be readily apparent. Australian researcher D. Keast detected a drop of 55 percent in blood glutamine immediately after a very intense interval workout.[7] He demonstrated that muscle glutamine synthesis capacities can be greatly overwhelmed during and immediately after intense training.

Australian researcher D. Keast detected a drop of 55 percent in blood glutamine immediately after a very intense interval workout. He demonstrated that muscle glutamine synthesis capacities can be greatly overwhelmed during and immediately after intense training.

Even more worrisome is the fact that the effect is very long lasting. In studies conducted at the University of Birmingham, England, Walsh and co-workers were not able to detect any fall in blood glutamine immediately after exercise, probably because they used a slightly lower training intensity than Keast.[6]

That means the muscle manufacturing capacities were able to keep up with the blood glutamine wasting for a while. Unlike Keast, who did a single post-training analysis, however, Walsh kept repeating his glutamine measures. He discovered that blood glutamine was 16 percent below normal five hours after the workout. It would seem that glutamine wasting eventually overwhelms the manufacturing capacities, perhaps as wasting continues accelerating and/or the synthesis process is exhausted. So, if you train at 6 p.m. for two hours, at 1 a.m., while you're sleeping, all your glutamine stores will be depleted.

According to the phenylbutyrate study discussed above, a lasting shortage of glutamine causes the protein synthesis rate to be depressed for a long while after training if no specific measures are taken. Since the overnight fasting also causes glutamine depletion, the two wasting processes combine to exacerbate catabolism. Needless to say, if you retrain your muscles while glutamine stores are still low, you'll get yourself into serious trouble. Your muscle will never have a chance to recover, which will lead to chronic overtraining.

The key points to remember here are as follows:

•Weight training depletes glutamine stores.

•It's a very long-lasting depletion.

•It's likely to be even more pronounced if you train at night.

Another probable cause of the long-term depletion of blood glutamine is the activation of the immune system by training. The immune cells use glutamine as fuel, which taxes the body reserves even further.

Why Is Glutamine Destroyed During a Workout?

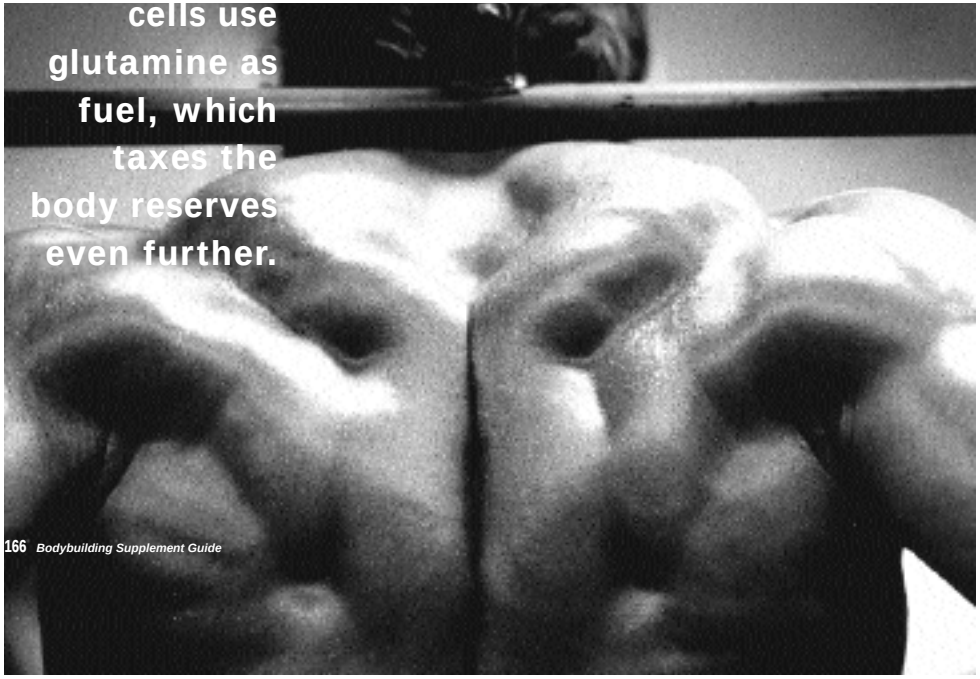
Training enhances the body's glutamine use through four major pathways. Intense training tends to rapidly increase the output of cortisol, which is a major waster of glutamine. That instantaneously increases the intestine's need for glutamine, which accelerates the extraction of it from the blood. Cortisol promotes the degradation of glutamine in the liver, further depleting blood glutamine.

Training increases your body's consumption of carbs, so the blood levels of both glucose and insulin are likely to decline. That causes the internal manufacture of carbs from noncarbohydrate molecules through a process called gluconeogenesis. Both the liver and kidneys attract amino acids—chiefly as alanine and glutamine—to transform them into carbohydrates.

Another major function of blood glutamine is to maintain the acid/base equilibrium. As you weight train, your muscles produce lactic acid, which passes into the blood and acidifies it. You can tell when that happens because your muscles burn at the end of an intense set.

The kidneys detect a drop in blood pH, forcing them to attract blood glutamine at an increasing pace. The renal consumption of glutamine can be enormous, which indirectly increases the bicarbonate level. Once the newly manufactured bicarbonate reaches the blood, it serves as a buffer and so binds the blood acid to render it neutral. That causes the blood pH to increase and the acid/base balance to be restored.

Another probable cause of the long-term depletion of blood glutamine is the activation of the immune system by training. The immune cells use glutamine as fuel, which taxes the body reserves even further.



The Case for Glutamine Supplementation

I hope I've given you a better understand of glutamine's role in your body. A key point is that training reduces both blood and muscle glutamine. While the muscles of some bodybuilders have sufficient glutamine to cover the immediate training-induced wasting, that's not the case for many. In a matter of a few hours they run short of glutamine because of the delayed actions of training, a shortage that's likely to occur in the middle of the night, when blood glutamine tends to be depressed for other reasons. So anabolism is reduced exactly when it's supposed to be boosted.

You may think that you can escape the problem by adding a few glutamine pills during the postworkout period. It's not that easy, though, and for two reasons: 1) Most of the oral glutamine doesn't make it to the blood, and 2) even if it does, it isn't likely to enter the muscle.

Your goal, therefore, is threefold: 1) minimize the wasting of glutamine during and after training, 2) compensate for the fall in glutamine stores and 3) find out if it's possible to load your muscles with glutamine as you do with creatine in order to upregulate anabolism.

Editor's note: *Michael Gündill is a respected European researcher who specializes in physiology, endocrinology, pharmacology and nutrition. He has weight trained for more than 15 years.*

References

[1] Rennie, M.J. (1996). Responses of glutamine transport in cultured rat skeletal muscle to osmotically induced changes in cell volume. *J Physiol* (Lond). 492:887.

[2] Taylor, P.M. (1998). The integrin-binding peptide GRGDTP prevents osmotically induced modulation of glutamine uptake in rat skeletal muscle. *J Physiol* (Lond). 509:195P.

[3] Darmaun, D. (1996). Effect of glutamine on leucine metabolism in humans. *Am J Physiol*. 271:E748.

[4] Darmaun, D. (1998). Phenylbutyrate-induced glutamine depletion in humans: effect on leucine metabolism. *Am J Physiol*. 274:E801.

[5] Perriello, G. (1997). Regulation of gluconeogenesis by glutamine in normal postabsortive humans. *Am J Physiol*. 272:E437.

[6] Walsh, N.P. (1998). The effects of high-intensity intermittent exercise on the plasma concentrations of glutamine and organic acids. *Eur J Appl Physiol*. 77:434.

[7] Keast, D. (1995). Depression of plasma glutamine concentration after exercise stress and possible influence on the immune system. *Med J Aust*. 162:15.

In a matter of a few hours bodybuilders run short of glutamine because of the delayed actions of training, a shortage that's likely to occur in the middle of the night, when blood glutamine tends to be depressed for other reasons. So anabolism is reduced exactly when it's supposed to be boosted.

Glutamine: The Essential Nonessential Amino Acid, Part 2

by Michael Gündill

The amino acid glutamine has a unique and key role in the muscle-building process. It's intimately linked to growth. The more glutamine your muscles contain, the more they'll grow. Therefore, you should attempt to load your muscles with glutamine. Unfortunately, that's easier said than done, and you face two major obstacles: 1) Intense training depletes glutamine stores, and 2) most of the glutamine you take in through food or supplements doesn't make it into the blood, much less to the muscle. The question, then, is, How do you force your muscles to accept glutamine when they refuse to let it in?

Weightlifting Wastes Glutamine Stores

Every time you train, you put a great strain on your glutamine reserves, with both blood and muscle glutamine becoming depleted. Muscles will respond by manufacturing new glutamine from other amino acids, especially the branched-chain amino acids (BCAAs); however, it's usually not sufficient to keep up with the accelerated glutamine wasting, and, of course, it also causes a shortage of BCAAs. As the body cannot synthesize BCAAs, you have to get them from food or supplements. Conversely, since they're glutamine precursors, taking supplemental BCAAs is a way to restore your body's glutamine reserves.

Training-induced glutamine wasting doesn't stop when your workout is over. It lasts a very long time and keeps accelerating in the postworkout period as your glutamine-manufacturing capacity becomes exhausted. It's up to you to provide enough glutamine or glutamine precursors to fill the gap between the depletion and the supply. Dietary amino acids alone won't be strong enough to fully ensure against a temporary glutamine shortage. You have to recruit the power of your endocrine system to help in the glutamine manipulation.

What Happens to Dietary Glutamine

Most of the glutamine you take in through food doesn't survive to enter your blood. It does increase your blood glutamine level,[1] but between 60 and 80 percent of dietary glutamine is taken up by the intestine and never reaches the blood. The 20 to 40 percent that's left is handy to have, but it won't be enough to meet the postworkout demand.

Why Would Glutamine Enter the Muscle Anyway?

Even if you could find a way to increase the level of glutamine in your blood, the real goal is to load your muscles with it. Not only would it refill the glutamine reserves, but it would also stimulate or support extra muscle growth. In theory, it's possible to coax the blood glutamine into entering your muscles, but in practice things aren't that simple for bodybuilders. The surface of each muscle cell contains glutamine transporters, or pumps, which are small holes in the cell membrane that open up to act as a channel for glutamine. Like vacuum cleaners they can be turned on and turned off.

In theory, when muscle glutamine levels are low, the glutamine pumps are turned on, and when you have an excess of muscle glutamine, they're turned off. Obviously, the off state is a major obstacle to loading your muscles with glutamine. It's a problem similar to the creatine pumps that stop working whenever muscle creatine levels reach a critical threshold.

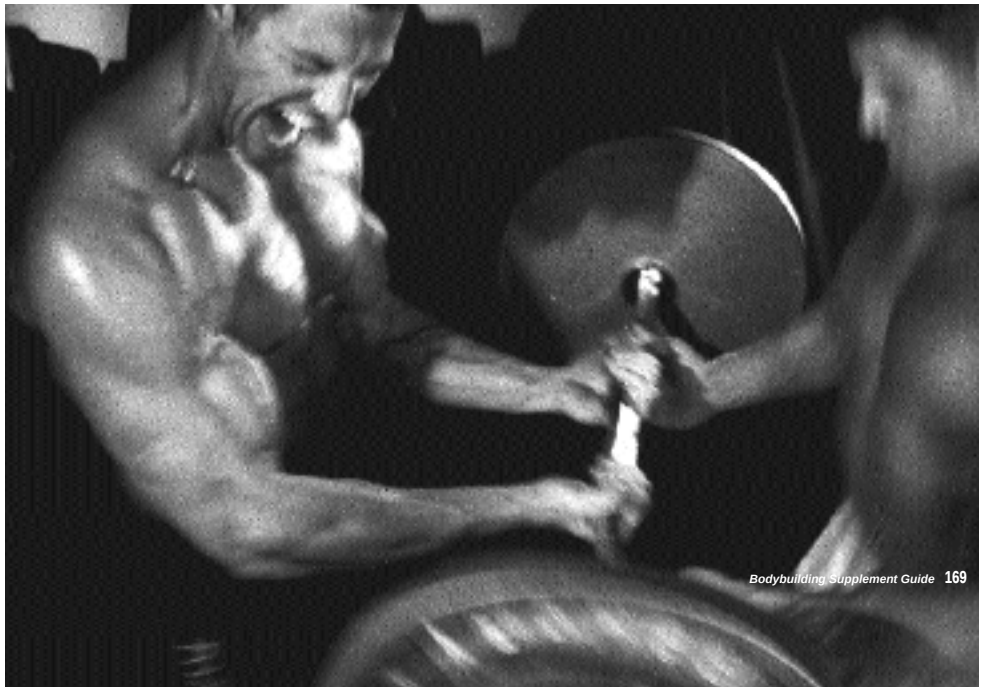
Although you might wish that in the post-training period the starving muscles would easily take up the dietary glutamine, it doesn't work that way. The glutamine transport from the blood to the muscle is said to be sodium dependent, which means that the muscle takes up the glutamine and some sodium. Once they're inside the cell, the glutamine is held back while the salt is pushed out. Even so—and despite what you may hear via the bodybuilding grapevine—eating extra salt won't help you with glutamine manipulation unless you're taking powerful diuretics.

The elegantly designed machinery works well unless the newly arrived salt isn't leaving the cell fast enough to match the rate of sodium entry. If the pumps that are forcing the salt out of the cell are overwhelmed, the ones that are pumping the extracellular salt into the muscle stop working, and when they stop bringing salt into the cell, they also stop pumping in glutamine.

There are several reasons why glutamine entry into the muscle is blocked after a workout. For one thing, high cortisol levels will impair it. For another, the muscle cells are already loaded with sodium. As a general rule, whenever there's an excess of sodium in the muscle, a wasting process is at work.

The unwanted invasion of sodium is due to several causes. During training muscle burn stimulates the entry of sodium in exchange for the acid responsible for the burning sensation. After training the wear and tear inflicted on the muscle cells precipitates the leak of blood sodium into the muscle. Although glutamine entry is sodium dependent, sodium doesn't necessarily bring glutamine along with it when it enters the muscle cell. In other words, sodium entry is not dependent on glutamine. While sodium can freely leak into the muscle, the process by

There are several reasons why glutamine entry into the muscle is blocked after a workout. For one thing, high cortisol levels will impair it.



When cortisol is high, all glutamine stores become depleted. It's important to keep your cortisol level under close scrutiny, as there's no way a dietary intake of amino acids or glutamine can counter its powerful negative influence.

which it is pumped out of the cell is energy, or ATP, dependent.

Unfortunately, ATP levels are reduced in the postworkout period, so the pump can't eliminate the sodium as fast as is required. The sodium loading ultimately translates into the slight muscle swelling that's apparent in the few days following a workout. It means that muscle glutamine entry is impaired—or at least slowed—not only during the workout but also for a long time afterward. That contrasts with the glutamine wasting, which is high during the same period.

Cortisol: Glutamine's Most Dangerous Enemy

Although a normal basal cortisol level can participate in muscle growth, an excess impairs the process. Intense training tends to bring you closer to that dangerous threshold. When cortisol is high, all glutamine stores become depleted. Cortisol forces your intestine and liver to increase their glutamine consumption, and it works with glucagon in the liver to destroy the glutamine. On top of that, cortisol favors sodium accumulation in the muscle, which may explain in part why cortisol severely impairs glutamine entry into the muscles while accelerating its exit. The result is a depletion of muscle glutamine in addition to the depletion caused by training. Consequently, it's important to keep your cortisol level under close scrutiny, as there's no way a dietary intake of amino acids or glutamine can counter its powerful negative influence.

Insulin Transports Glutamine

If some hormones cause glutamine depletion, others have the opposite effect. Insulin is your first ally in glutamine manipulation. Glutamine is one of the few amino acids whose entry into the muscle can be enhanced by insulin, and you can certainly see the advantage of that. Any attempt to load up on glutamine should take advantage of the insulin-booster effect.

Some of the favorable actions of insulin are brought about by its influence on sodium. Insulin helps your muscles get rid of the extra sodium, which is a very interesting property in light of the sodium invasion that follows training. What's more, the anabolic effects of insulin and glutamine reinforce each other and can only be maximum when both are present.

The Mighty GH

Growth hormone (GH) was made to work along with glutamine, and vice versa. Bodybuilders have long been aware of the close relationship between the two because of the fact that oral glutamine can increase GH.[1] On the other hand, they may not be aware that GH also increases glutamine levels in both blood and muscles without the necessity of any particular dietary change. Therefore, GH is truly the mighty ally you're looking for in glutamine manipulation.

One of the ways GH works is to limit the wasting of glutamine in the liver, where it can be transformed into urea. The urea is ultimately excreted in the urine, which means the glutamine is wasted simply because there's a catabolic process at work. Research has shown that GH shunts the "extracted glutamine nitrogen from urea via hepatic glutamate release."[3] The newly formed glutamate can be transformed into glutamine in the muscle. So, instead of allowing glutamine to be urinated as a waste product, GH favors the recycling of it.

GH also has another major preserving effect on glutamine in the kidneys. As discussed in Part 1 of this series, one of the reasons glutamine degradation is accelerated after training is that lactic acid accumulates in the blood. That lowers plasma pH and forces the kidneys to extract circulating glutamine at a very fast pace. GH helps your kidneys to get rid of the acid load and as a result reduces their need for glutamine.[4] Oral glutamine synergizes with GH at that point, not only by increasing the GH level but also by helping the hormone get rid of the acid that's generated by training.[1] Other favorable effects of GH on glutamine are brought about indirectly by the elevation of insulinlike growth factor (IGF-1), a peptide that shares many of the positive actions of insulin on glutamine.

Testosterone Boosters to the Rescue

Research has shown that an elevation of androgen spares muscle glutamine content in catabolic situations. While part of that action of testosterone is likely to be direct, androgen precursors will synergize with many of the hormones discussed above as well. A good GH booster will work well with testosterone. Phosphatidylserine and vitamin C, which help control the secretion of cortisol, will synergize with the prohormones to prevent the glutamine-wasting actions of corticoids.

Techniques for Glutamine Manipulation

Effective glutamine manipulation will include three distinct steps:

1) Reduce the training-induced glutamine wasting.

2) Refill the glutamine stores to prevent a shortage of glutamine.

3) Attempt glutamine loading.

The first two steps are meant to combat some of the catabolic effects of training and enhance recovery. The third step is more aggressive, as it attempts to boost anabolism through dietary and endocrine manipulation rather than training. In fact, it tries to duplicate what you're already doing with creatine.

Here's a rundown of how to take those steps.

1) Reduce the training-induced glutamine wasting. At this point your best ally is the carb drinks. Blood glucose levels tend to fall during

Research has shown that GH shunts the "extracted glutamine nitrogen from urea via hepatic glutamate release." The newly formed glutamate can be transformed into glutamine in the muscle. So, instead of allowing glutamine to be urinated as a waste product, GH favors the recycling of it.

Drinking a casein drink or a casein-and-whey formula before a workout ensures the slow but long-lasting release of both glutamine and BCAAs while you train. If you can afford a glutamine supplement, use it before, rather than during, your workout.

training. As a result, insulin secretion is repressed while the secretions of cortisol and glucagon are enhanced. You want to reverse the situation, which is easily accomplished by increasing your carb intake before your workout and using a carb drink through the session. Studies have shown that carb drinks boost glutamine output at the end of a workout by cleaning out many of the waste products that accumulate in the muscles during exercise. That's a double advantage you shouldn't neglect. A preworkout stack of both GH and testosterone boosters along with phosphatidylserine and vitamin C will enable you to go beyond what you can achieve with a simple dietary manipulation.

2) Refill the glutamine stores to prevent a shortage. The proteins derived from casein are usually the richest in glutamine; however, many manufacturers of whey supplements add extra glutamine to their proteins to make up for the comparative disadvantage. Drinking a casein drink or a casein-and-whey formula before a workout ensures the slow but long-lasting release of both glutamine and BCAAs while you train. If you can afford a glutamine supplement, use it before, rather than during, your workout. If you're on a tight budget, though, skip the glutamine at this point in your supplement schedule. Oral BCAAs are cheaper and more appropriate to the situation. As glutamine precursors, they're rapidly transformed into glutamine in the muscles. BCAAs have the advantage of building up the glutamine stores while bypassing the intestine barrier and the problem of getting into the muscle.[2]

Once your workout is over, have a shake made of fast-acting whey protein instead of going home with an empty stomach. If your whey is reinforced with glutamine, it's not crucial that you also take glutamine pills at this point either. The protein drink will combat the short-term post-training glutamine depression.[6] I like to add creatine in order to help refill muscle ATP, which will be essential for the transport of muscle glutamine.

You should eat a normal meal 30 to 45 minutes after your post-training protein drink. If you train in the morning, you can have a meal rich in both proteins and carbs. If you train at night, you want to be very careful about your carb intake at that hour if you want to remain reasonably lean. That's where glutamine pills can come in handy. To help your body fight the training-induced long-term wasting, take two grams of glutamine every hour for four hours—and skip the BCAAs, as they're said to compete with glutamine for entry into the muscle. You can help accelerate the entry of glutamine into the muscle by also using compounds that help accelerate the pumping of sodium out of the cell. Insulin release after carb intake is one.

3) Attempt glutamine loading. This may well be the most controversial aspect of the process. Is it possible to load your muscles with glutamine to force them to grow? Most specialists would agree that it's very hard to boost glutamine beyond normal levels in the muscles. A simple dietary ingestion of it is bound to produce limited results because of the absorption and muscle-entry problems. The experts usually recommend very high doses of glutamine to bypass those problems. The high doses reflect the limitations of our knowledge about the amino. The powerful effects of GH demonstrate that relatively small doses of glutamine can boost muscle glutamine considerably. Until science provides us with more appropriate tools for delivery, however, taking high doses of at least 15 grams a day is the only way to go.

In a very recent study researchers were able to load subjects' muscles with glutamine without increasing glutamine doses. Instead, they used a very interesting compound called dichloroacetate (DCA).[7] Under various conditions DCA can increase muscle performance in humans. It did increase muscle glutamine levels rapidly. That's the good news. The bad news is that it was used on burn patients and failed to increase protein synthesis. Nevertheless, it is certainly a very promising compound for bodybuilders.

Here are some key points about glutamine to remember:

•GH is of utmost importance for preserving glutamine and loading the muscles with it.

•Insulin accelerates glutamine transport, which is usually a rate-limiting step.

•You must keep cortisol levels under control, or your dietary glutamine will all be wasted.

Editor's note: *Michael Gündill is a respected European researcher who specializes in physiology, endocrinology, pharmacology and nutrition. He has weight trained for more than 15 years.*

References

[1] Welbourne, T. (1998). An oral glutamine load enhances renal acid secretion and function. *Am J Clin Nutr*. 67:660.

[2] Wu, G. (1998). Intestinal mucosal amino acid catabolism. *J Nutr*. 128:1249.

[3] Welbourne, T. (1989). Growth hormone effects on hepatic glutamate handling in vivo. *Am J Physiol*. 257:E959.

[4] Welbourne, T. (1991). Growth hormone accelerates tubular acid secretion. *Am J Physiol*. 260: R1036.

[5] Galassetti, P. (1998). Enhanced muscle glucose uptake facilitates nitrogen efflux from exercised muscle. *J Appl Physiol*. 84:1952.

[6] Saris, W.H.M. (1997). Ingestion of drinks containing protein hydrolysate prevents the postexercise reduction of plasma glutamine. *Int J Sports Med*. 18: S115.

[7] Ferrando, A.A. (1998). Acute dichloroacetate administration increases skeletal muscle free glutamine concentrations after burn injury. *Ann Surg*. 228:249.

•GH is of utmost importance for preserving glutamine and loading the muscles with it.

•Insulin accelerates glutamine transport, which is usually a rate-limiting step.

•You must keep cortisol levels under control, or your dietary glutamine will all be wasted.

Hormonal Wars: The Conflict From Within

by Jerry Brainum

While you may not be aware of it, a struggle for biochemical domination is occurring within you. The victor of this war ultimately determines whether you make muscular gains or lose muscle and even get fat. The two combating armies are collectively called anabolic and catabolic hormones. The most familiar of them from a bodybuilding perspective are testosterone (anabolic), growth hormone (anabolic), insulin (anabolic) and cortisol (catabolic).

Anabolic refers to the metabolic building processes. The actions of anabolic hormones involve either an increase in muscle protein synthesis or a decreased breakdown of muscle protein. Increased breakdown of muscle is the chief characteristic of catabolic reactions. You would think that since cortisol, the body's primary catabolic hormone, is so outnumbered by the anabolic forces, it would be more or less an ineffectual player in the hormonal battle between anabolic and catabolic reactions, but that isn't the case.

Since cortisol, a product of the adrenal gland cortex, is a primary stress hormone, it's activated by any type of stress the higher brain centers that govern its release perceive. Since stress is ubiquitous, the body is constantly secreting cortisol, with peaks in the early morning hours and a low during the initial stages of deep sleep.

While cortisol has gotten a bad reputation among bodybuilders due to its potent catabolic activity and tendency to promote bodyfat accretion, the fact remains that it's also essential to life. During stress reactions it's the first line of defense in, among other functions, maintaining energy levels and blood pressure. While such reactions can be lifesaving under certain circumstances, when you're resting or after you exercise, the results are hardly desirable. They include muscle loss, mineral excretion, sodium retention and other enemies of bodybuilding progress.

For natural bodybuilders, meaning people who eschew all forms of pharmaceutical bodybuilding assistance, controlling cortisol is vital for muscle gains. Note the use of the word *controlling.* You don't want to totally eliminate cortisol activity in your body, as that would be a life-threatening condition.

The key is to control the catabolic reactions induced by cortisol while emphasizing the anabolic processes that promote increased muscle growth. You do that by upping your body's production of the endogenous anabolic hormones mentioned above by both following a sensible training program and using certain specific nutritional substances and diet techniques.

Let's get one thing straight, however. No natural food or supplement can match the power of drugs such as anabolic steroids. Such steroids promote muscle gains through two primary mechanisms: 1) increased muscle protein synthesis and 2) decreased catabolic reactions in muscle. The first mechanism involves a genetic alteration of certain protein synthesizing enzymes that simply can't be duplicated by any known food supplement; however, the second process, anticatabolism, can be manipulated without drugs.

Research concerning the mechanisms of anabolic steroids shows that most of their effects come from their anticatabolic activity. The upgraded protein synthesis is relatively ephemeral, lasting only a few weeks at best. After that it's all anticatabolic, as the steroids somehow counteract the actions of cortisol in muscle.

Exactly how they accomplish this anticatabolic activity is still subject to debate. While some people say that steroids block cellular cortisol receptors in a manner similar to the way another drug, Nolvadex, blocks estrogen cell receptors, that doesn't add up. For one thing, muscle tissue contains at least 50 times more cortisol receptors than androgen receptors, the receptors anabolic steroids

Recent studies show that consuming carbohydrates and protein immediately following a workout both increases insulin release and potently blunts cortisol.

interact with. A more plausible explanation is that such steroids can interfere with cortisol activity in muscle, most likely at the gene level.

How Cortisol Breaks Down Muscle

Understanding cortisol's catabolic activity in muscle provides some insight into the way certain food supplements may help spare muscle by inhibiting it. Cortisol is known to reduce body protein stores in all tissues except for the liver. It does that through several mechanisms, including a reduction in the synthesis of cellular RNA, which is essential for protein synthesis. Since anabolic steroids promote muscle protein synthesis by increasing RNA, cortisol has exactly the opposite effect.

Cortisol mobilizes amino acids from muscle for transport to the liver, where they undergo a process called gluconeogenesis that results in increased glucose production. While this is vital for a rapid source of energy during severe stress, it also results in muscle breakdown. Insulin opposes cortisol in the action, but high stress activity promotes cortisol domination over insulin.

A study conducted about two years ago showed that as little as two grams of oral glutamine significantly increased growth hormone release. That alone would give you an anticatabolic effect, since growth hormone opposes the actions of cortisol in muscle.

Recent studies show that consuming carbohydrates and protein immediately following a workout both increases insulin release and potently blunts cortisol. The dosage of carbs required for this effect is one gram per kilogram (2.2 pounds) of bodyweight taken immediately after training and again one hour later. In addition, including at least 50 grams of protein helps maximize insulin release.

Cortisol appears to promote the synthesis of a protein-degrading substance called ubiquitin that rapidly breaks down muscle. Interestingly, a drug called clenbuterol that's favored by some bodybuilders may work by inhibiting ubiquitin synthesis in muscle, thereby exerting an anticatabolic effect. Other hormones, such as growth hormone and insulinlike growth factor 1 (IGF-1), appear to inhibit the ubiquitin system as well.

Cortisol also works by stimulating the exit of the amino acid glutamine from muscle. When that occurs, rapid muscle catabolism follows. Several studies show that taking supplemental glutamine may block much of the catabolic effects of cortisol in muscle. The problem is, many of the studies that show an anticatabolic effect of glutamine used intravenous solutions containing a stable dipeptide—up to 40 grams of glutamine in a complex with another amino acid, alanine.

If you attempted to take that quantity of glutamine orally, most of it would not reach your blood or muscle. Intestinal cells, which are replaced about every three days as they slough off during the process of food movement through the gut, use glutamine as fuel. When you take it orally, about 85 percent of a dose of glutamine goes to the intestinal cells. Even if it were somehow to survive the intestinal hijacking, the liver has enzymes just waiting to degrade the rest of it.

Nevertheless, a study conducted about two years ago showed that as little as two grams of oral glutamine significantly increased growth hormone release. That alone would give you an anticatabolic effect, since growth hormone opposes the actions of cortisol in muscle. In fact, studies indicate that decreasing cortisol release in the body results in an upgraded growth hormone response.

Some preliminary studies show that vitamin C may also inhibit the catabolic actions of cortisol; however, the evidence is not particularly impressive. More likely, substances like branched-chain amino acids and even dietary fat are the nutritional cortisol inhibitors.

A new study reported at the 1997 meeting of the American College of Sports Medicine found that one of the branched-chain amino acids, leucine, successfully reduced the catabolic effects of cortisol in rat muscle without affecting muscle glutamine levels. That's interesting because past studies showed that BCAAs work by either increasing muscle glutamine synthesis or preventing its release under the influence of cortisol.

Another study, reported at the Experimental Biology 97 meeting in New Orleans, examined the effects of dietary fats on plasma hormones in runners. The study compared three levels of fat composition in the diets of the runners: 17 percent, 32 percent and 41 percent. The results showed that the 32 percent fat diet significantly reduced cortisol levels in the runners compared to the 17 percent fat diet. Under the 42 percent, or high-fat, diet, cortisol levels increased only marginally. The diet lowest in fat produced the highest cortisol levels.

The authors of this study suggest that higher fat diets may help eliminate some of the excess cortisol release through an upgraded prostaglandin synthesis. Prostaglandins are hormonelike substances made from dietary fat that, among other actions, influence hormonal secretions. They were recently popularized by the best-selling diet book *Enter the Zone*, by Barry Sears.

Another possible explanation for the way a high-fat diet dilutes cortisol involves increased testosterone production. Testosterone has an inverse relationship to cortisol; that is, when testosterone is elevated in the blood, cortisol is depressed and vice versa. When testosterone is elevated, anabolic muscle reactions occur.

Natural bodybuilders seeking to key in to the anticatabolic effects of testosterone without using synthetic versions, such as anabolic steroids, often resort to purported testosterone precursors. These over-the-counter products fall into a gray area of legality due to the Food Supplement Act of 1994. Consequently, they are freely available and legal, at least for now.

One example of a reputed testosterone precursor is the adrenal hormone DHEA, which is produced in the pathway that begins with cholesterol and results in testosterone. That could be a problem, however, as DHEA, in some instances, may take divergent pathways, winding up as either an undesirable by-product of testosterone metabolism called dihydrotestosterone (DHT) or, even worse, estrogen. DHT is linked to male pattern baldness, prostate enlargement and acne, while estrogen, in males, leads to gynecomastia, increased fat deposition under the skin and water retention.

Those over age 40 will probably get the most benefit from DHEA. At that point in people's lives DHEA synthesis generally undergoes a precipitous drop, in which case conservative doses of 50 milligrams a day may take the desirable testosterone pathway by converting to the immediate precursor to testosterone, androstenedione.

Recently, androstenedione itself became available as an oral supplement. Some studies show that a liver enzyme can convert androstenedione directly into testosterone, which can increase plasma testosterone levels up to 300 percent over baseline for about two hours; however, it can also be converted by another enzyme, aromatase, into estrogen. In addition, no one has figured out how long an oral supplement of androstenedione continues to remain effective—assuming that it is effective for testosterone-raising purposes.

Still another over-the-counter hormone that has been suggested as a cortisol blocker is melatonin, a hormone synthesized in the pineal gland of the brain from the amino acid tryptophan. While melatonin is un-

The authors of this study suggest that higher fat diets may help eliminate some of the excess cortisol release through an upgraded prostaglandin synthesis. Prostaglandins are hormonelike substances made from dietary fat that, among other actions, influence hormonal secretions.

Anabolic/Anticatabolic Q&A

Q: You've done a lot of research on insulin. Is it a bodybuilder's friend or foe? Should hardgainers try to get insulin surges throughout the day via high-glycemic-index carb intake to kick-start anabolism and blunt cortisol release, or will that have negative effects?

A: Insulin is a storage hormone that has the capacity to increase fat deposition, foster carb storage as glycogen and help increase muscle protein synthesis by promoting amino acid uptake in muscle while blunting cortisol's catabolic effects. One study attributes 30 percent of muscle protein synthesis to insulin activity.

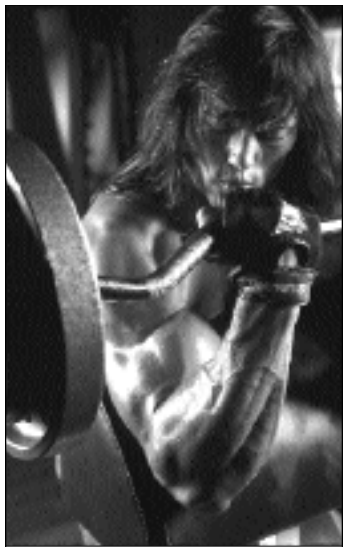
In addition, insulin may increase free or active testosterone levels through several possible mechanisms. These include inhibition of SHBG, a protein produced in the liver that binds to testosterone in the blood, thus keeping it dormant. Lowering SHBG increases free or active testosterone levels. Insulin may also promote the activity of an enzyme in the testes needed for testosterone synthesis. Finally, insulin may inhibit aromatase enzyme, which converts free testosterone into estrogen.

As such, insulin can be either good or bad, depending on how you control it. For most people attempting to produce insulin surges throughout the day will promote both hunger and increased bodyfat deposition. The main advantage to consuming frequent but small meals is that they support a more even insulin release, thus avoiding the surges produced by taking in too many calories—which promotes excessive insulin release and subsequent bodyfat synthesis.

I've noticed through the years that the types of diets that result in the lowest percentage of bodyfat in bodybuilders are those that control insulin release. Simply put, when insulin is controlled, you burn much more fat. That's the whole point of low-carb diets. For some people, however, such extreme low-carb plans don't work well, but even for them, controlling insulin release through properly timed carb intake will result in greater bodyfat losses.

I think it's beneficial to have an insulin spike as soon as possible after training, since many studies show that increased insulin at that time promotes increased muscle glycogen synthesis, greater amino acid uptake into muscle and decreased cortisol. The best way to do that is to consume half a gram of simple carbs per pound of bodyweight along with enough protein to equal 40 percent of the carb dose. For example, a 200-pound bodybuilder would consume 100 grams of high-glycemic carbs with 40 grams of protein. Whey protein is the preferred postworkout protein source because it can be rapidly absorbed.

Adding glutamine to this mix may also help, since intense training causes glutamine to exit from muscle. Glutamine is important for maintaining optimal immune response and aids muscle protein synthesis. About four grams after training is a good dose, as too much will either be degraded in the liver or absorbed by intestinal cells. By the way, there's absolutely no evidence that combining glutamine with lysophosphatidylcholine, as is the practice with some current glutamine supplements, increases the uptake of oral glutamine. Lysocholine is, however, linked to duodenal ulcers and atherosclerosis.



The best protein supplements contain casein and whey protein along with glutamine peptides—an ideal mix that promotes optimal growth and less muscle wasting.

One researcher a few years ago came up with the idea of consuming a simple carb-and-protein mixture during training. He noted that insulin secretion during exercise is usually depressed by epinephrine. He thought that consuming the nutrient mixture would overcome this brake and thus release insulin during training. The insulin released would preserve muscle and might even provide an anabolic effect.

The technique would be especially useful for hardgainers who have no carb-sensitivity problems, since it would maximize insulin output without the hazard of insulin's fat-promoting effect. The downside is that you'd have to drink at least two quarts of the stuff, and that could lead to an uncomfortable bloated effect in many people. In addition, the insulin produced by this method would totally obviate any fat-burning effect of the workout, and people with insulin insensitivity may acquire more bodyfat than lean mass.

Another way to control cortisol release involves using a phosphatidylserine (PS) supplement. A new study that used active bodybuilders was recently presented at the American College of Sports Medicine meeting in Orlando, Florida. This study confirmed that PS does indeed safely inhibit cortisol release, lowering it by around 30 percent. This represents a significant—but safe—decrease in cortisol output. You never want to totally curtail cortisol, since that could be fatal.

A few emerging animal-based studies also show that ginko biloba, a substance derived from some of the world's oldest trees, also appears to lower cortisol output in a manner similar to PS. Since those new studies don't involve human subjects, the results must await confirmation in studies that do. Unless you want to use ginko as a brain nutrient, stick with PS for cortisol control for now.

—Jerry Brainum, bodybuilding and nutrition researcher

This study confirmed that PS does indeed safely inhibit cortisol release, lowering it by around 30 percent. This represents a significant—but safe—decrease in cortisol output.

Q: Does the food supplement phosphatidylserine offer any real bodybuilding benefits? If so, is there any scientific data to prove its efficacy?

A: PS, as it's known, is a phospholipid, a combination of fatty acids and phosphorus plus the amino acid serine. It's a ubiquitous substance in the body, found in cell membranes, and research has shown that the body's synthesis of PS may not be optimal as people age. Since much of a person's PS is concentrated in the brain, which is composed mostly of fat, older people may be deficient in the substance—a notion that's underscored by several well-controlled studies. In the experiments researchers found that providing an average dose of 300 milligrams per day of PS to older people who have memory defects seemed to help them.

The idea of using PS to combat stress reactions induced by high cortisol levels first surfaced in a 1990 study reported in the journal *Neuroendocrinology*. In 1992 the same researchers published another study that pointed to an athletic use for PS. That study involved untrained cyclists who took 800 milligrams of PS for 10 days prior to exercising on bicycles to near exhaustion. The results indicated that PS appeared to lower cortisol by about 30 percent. The effect was noted only for an 800-milligram dose; however, 400 milligrams didn't have the same effect on cortisol release.

Cortisol is a stress hormone produced in the adrenal cortex. The con-

Since the anabolic hormones are required for optimal muscle protein synthesis, the effect of cortisol in breaking down muscle and interfering with new muscle growth via anabolic hormone release clearly points to the need to control, but not to eliminate, cortisol release.

trol of cortisol is based on a hormonal cascade effect involving an initial release of corticotropin-releasing hormone from the hypothalamus, followed by ACTH from the pituitary gland. ACTH then travels in the blood to the adrenal glands, where it dictates the release of several hormones, including cortisol.

Cortisol has acquired a bad reputation among bodybuilders because of its catabolic, or breakdown, effects in muscle. Muscle tissue is loaded with cortisol hormone receptors; in fact, cortisol receptors outnumber androgen receptors by 50 to 1. In muscle cortisol promotes the breakdown of muscle amino acids, which then travel in the blood to the liver, where they're converted into glucose in a process called gluconeogenesis.

While it sounds bad, the breakdown of muscle protein induced by cortisol is a protective function of the body that's designed to provide needed fuel (glucose) under high-stress conditions. Unfortunately, the body doesn't differentiate between good stress and bad stress, so the stress of exercise results in the same cortisol catabolic effects as trauma to the body. In addition, cortisol suppresses immune response, which explains why it's so much easier to get sick when you're under stress. Even sleep disturbances can lower immune response by 40 percent.

Cortisol also has an inverse relationship to anabolic hormones, such as testosterone, growth hormone and insulin. When cortisol is elevated, the other hormones are depressed. Since the anabolic hormones are required for optimal muscle protein synthesis, the effect of cortisol in breaking down muscle and interfering with new muscle growth via anabolic hormone release clearly points to the need to control, but not to eliminate, cortisol release.

Some athletes resort to drugs that either block the effects of cortisol or inhibit its synthesis in the adrenal glands. Examples of blocking drugs include anabolic steroids, which are synthetic forms of testosterone. While the precise mechanism behind the cortisol-inhibiting effect of anabolic steroids isn't known, one theory holds that steroids exert a competitive inhibition against the binding of cortisol to its cell receptors in muscle. The theory is complicated, however, by the fact that there are far more cortisol receptors in muscle than androgen receptors. Most of the long-term effects of anabolic steroids in promoting muscle growth and recovery are related to the cortisol-inhibition effect.

Another popular drug for controlling cortisol is aminoglutethimide, often sold under the trade name Cytadren, which works at the adrenal level by preventing the synthesis of cortisol that begins with cholesterol. While effective for that purpose, Cytadren may also produce such side effects as nausea, vomiting, bone marrow depression and skin rashes.

I recall an instance a few years ago, in which I was called to the room of a top-level pro bodybuilder who was preparing to compete in a major contest. He complained of severe lethargy and appeared to have difficulty keeping his eyes open. When I asked him what he was taking, he replied, "Cytadren and Orimeten." No wonder he was lethargic: He was doubling up on the same drug because Orimeten is another trade name for it. Lethargy, such as the man experienced, occurs in 40 percent of people taking aminoglutethemide.

In truth, any anabolic drug, including IGF-1, growth hormone, anabolic steroids and insulin, can block most of the catabolic effects of cortisol. Those drugs, however, are not only illegal without a prescription, but they also have potential side effects. For a person primarily interested in health, such drugs aren't an option for cortisol control. That's where PS enters the picture.

Based on the two studies discussed above, PS has been suggested as a natural alternative for cortisol control, with the usual dose being 800 milligrams a day. A major criticism of that suggestion, though, is the lack of studies showing that it provides benefits for people engaged in intense weight training. After all, riding a bike is one thing in terms of muscle stress, but hoisting heavy weights several days a week is quite another.

The dearth of studies concerning the effects of PS on an active weight-training population led researchers Tom Fahey and Michelle Pearl of California State University, Chico, to design a new study for that purpose. Their experiment incorporated a double-blind, crossover design, meaning that neither the researchers or the subjects knew who was getting PS and who was getting a placebo. The placebo in this case consisted of lecithin, a good choice, since lecithin, like PS, is derived from soybeans. Fahey and Pearl presented their results at the recent American College of Sports Medicine meeting in Orlando, Florida.

The study featured 12 fit males with at least four years of weight-training experience (one man dropped out of the study due to appendicitis), who were all in good health and took no anabolic steroids or any other performance-enhancing drugs. They participated in a two-week training period consisting of four sessions a week. The workouts were especially intense whole-body sessions, in which the subjects trained with heavy weights, averaging five sets per exercise. Large muscle groups were emphasized in the routines, which were designed to promote overtraining.

The men were assigned to either a PS group or a placebo group. The men receiving genuine PS used a dosage of 800 milligrams a day. At the end of two weeks the subjects took a three-week break, then switched treatments—the "crossover" design—for another two-week period of supplementation and training. Fahey and Pearl measured various hormone levels during the course of the study, including cortisol, ACTH, luteinizing hormone (LH) from the pituitary gland and testosterone. The muscle enzyme creatine kinase was also assessed as a measure of exercise-induced muscle damage, and the subjects reported subjective feelings of well-being and muscle soreness.

During the first days of training cortisol levels were similar in both the PS and placebo groups, but by the eighth workout the PS group

Some athletes resort to drugs that either block the effects of cortisol or inhibit its synthesis in the adrenal glands. Examples of blocking drugs include anabolic steroids, which are synthetic forms of testosterone.

When cortisol remains elevated, the body turns on itself, literally feeding on hard-earned muscle, which is broken down into amino acids and converted to glucose in the liver in a process called gluconeogenesis.

showed lower cortisol levels. Levels of ACTH, which controls cortisol release, didn't change in the PS men, but they rose by 50 percent in the placebo group. Testosterone initially increased in the PS group, but it dropped in both the PS and placebo groups by the end of the study. That isn't surprising when you consider that the men were purposely overtraining, which has an established effect in blunting testosterone release. LH also rose only in the PS group.

The men taking the PS reported a greater feeling of well-being and less muscle soreness, both of which were based on a 10-point subjective scale. The researchers concluded that PS appears to lower cortisol after exercise and increase feelings of well-being while blunting muscle soreness. Similar to the results of older studies on PS, those findings suggest that the mechanism involves a PS-induced inhibition of ACTH release by the pituitary gland. The fact that ACTH didn't rise in those taking PS but did in the placebo group substantiates that idea.

Fahey and Pearl's preliminary study suggests that PS may be an effective and safe way to control cortisol output without resorting to potentially dangerous drugs. Although the men in the new study reported less muscle soreness, anecdotal reports from bodybuilders who have used PS indicate that a common side effect is increased joint soreness.

While that may not be comfortable, it also indicates that PS may work as advertised. Cortisol is a potent anti-inflammatory hormone in the body, and anything that interferes with cortisol activity is capable of producing joint tenderness, which is also a commonly seen side effect of the potent cortisol-suppressing drugs discussed above.

—Jerry Brainum, bodybuilding and nutrition researcher

Q: I keep reading about cortisol and its relationship to muscle catabolism. If it's so destructive, why does the body produce it, and how can I stop it from slowing my muscle growth?

A: The answer to that question lies deep in our DNA. Cortisol is actually a holdover from our 4-million-year-old genetic design. When the body is stressed, it triggers the "fight or flight" survival mechanism, which can shoot cortisol levels way above normal. The biological design of cortisol is such that when primitive man was threatened or angry, cortisol levels rose and mobilized his body for action by breaking down fat and muscle stores to use for emergency fuel and to reduce swelling in the event of injury.

For today's serious athletes training is trauma, and the body interprets every workout as a threat to survival. Mental stress produces the same negative response in the body as physical stress. The one-two punch of modern physical and mental stressors results in overload, which can leave your adaptive system overwhelmed by ongoing calls for cortisol production. As a result, cortisol levels may not get a chance to return to normal for long periods, and when cortisol remains elevated, the body turns on itself, literally feeding on hard-earned muscle, which is broken down into amino acids and converted to glucose in the liver in a process called gluconeogenesis.

Higher cortisol levels also reduce or even block the entry of anabolic building blocks essential for protein synthesis. That means when cortisol is high, expensive dietary amino acid and protein supplements are less likely to do their main job of cellular repair and growth.

Anabolic steroids appear to inhibit the catabolic effects of cortisol. It's a known fact that cortisol levels skyrocket when athletes stop using steroids. Phosphatidylserine (PS) is a natural substance that has been shown to suppress cortisol by more than 30 percent, which is why I think it's the king of the anticatabolic compounds. And it can actually amplify the effects of other supplements.

A number of European studies verified the anticatabolic effects of PS, and more recently Thomas Fahey of California State Univeristy, Chico, did a study with PS and anaerobic athletes. It once again proved its tremendous power by reducing blood cortisol levels during and after bodybuilding-type workouts, lighting the fuse for explosive size-and-strength increases.

This underscores the fact that PS supplements like Muscle-Link's Cort-Bloc should be a staple of all mass-seeking bodybuilders, especially those who don't use drugs. Choke off the devastating effects of cortisol and you'll grow as you never have before.

—Bob Fritz, research-and-development technician, Muscle-Link

Q: I've tried Cort-Bloc and made great gains with it, but someone told me that blocking cortisol can be dangerous. Is that true?

A: Blocking cortisol completely, as some drugs such as Cytadren do, for long periods can be dangerous; however, the study done with phosphatidylserine by Thomas Fahey showed that the natural compound suppressed cortisol by about 30 percent. That percentage isn't high enough to be dangerous, but it is enough to reduce catabolism and have a significant beneficial effect on muscle growth.

If you're still not convinced, check out Jerry Brainum's *Applied Metabolics* #13. He discusses a new study that was reported in the *Journal of Applied Physiology* (1998) that looked at the effects of low cortisol during exercise. Jerry's conclusion of the study is as follows:

While cortisol is important, blocking its effects during exercise isn't harmful and doesn't adversely affect exercise performance. The reason is that when cortisol is blocked, the activities of other hormones that regulate blood glucose levels—such as growth hormone, epinephrine and norepinephrine—increase to counter the effects of lowered cortisol.

That means your great gains from Cort-Bloc were not only due to reduced catabolism but were no doubt the result of a nice uptick in growth hormone as well. It also means that controlling cortisol with phosphatidylserine is completely safe. [A 12-issue subscription to *Applied Metabolics* is $29.95 for domestic, $49.95 for foreign and Canadian. Call (805) 570-4766.]

—Steve Holman, editor in chief, IRONMAN

Anabolic steroids appear to inhibit the catabolic effects of cortisol. It's a known fact that cortisol levels skyrocket when athletes stop using steroids.

Because cortisol can cripple your GH release, taking a PS supplement right before bed can make your natural GH pulse that occurs during the first few hours of sleep much stronger. The result will be better recovery and more muscle growth.

Q: When should I use Cort-Bloc for best effects?

A: Even if you're not using GH Stak, you can still get tremendous anabolic, anticatabolic benefits from Cort-Bloc. My advice is to use it at two strategic times during the day to decrease catabolism, increase growth and recovery and heighten your natural GH surges. First, use it before you train to help blunt the effects of cortisol, which will increase significantly during and right after you train. The second strategic time to take it is about an hour before bed. Because cortisol can cripple your GH release, taking Cort-Bloc right before bed can make your natural GH pulse that occurs during the first few hours of sleep much stronger. The result will be better recovery and more muscle growth.

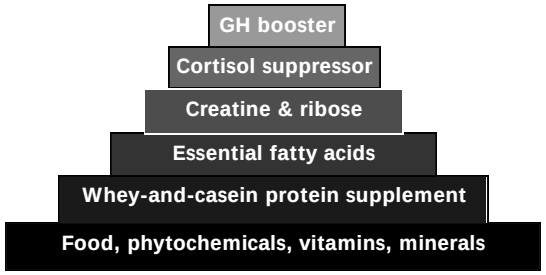
If you're taking GH Stak before bed, you'll want to take your Cort-Bloc with your last meal at around 7 p.m., instead of right before you go to sleep. Your stomach has to be empty to maximize the effects of the GH Stak, so make sure you take your Cort-Bloc three hours before your GH Stak.

—John Balik, publisher, IRONMAN

Q: Please outline a diet and supplement schedule that incorporates the most effective supplements so I can grow as quickly as my genetics will allow.

A: The diet/supplement schedule on the next page is an excellent one to start with; however, keep in mind that it is just a template. You'll probably have to adjust portions to find your perfect calorie total. The supplements are based on the anabolic/anticatabolic pyramid, which appears in *Size Surge 2.*

—Steve Holman, editor in chief, IRONMAN



ANABOLIC/ANTICATABOLIC DIET AND SUPPLEMENT SCHEDULE

6:30 a.m.: **Effervescent Creatine Elite, 1 packet (5 grams) or AnaVol-R**

7 a.m.:	**Calories**	**Protein**	**Fat**	**Carbohydrates**
Protein drink, such as Muscle-Link's Pro-Fusion*	200	40	2	5
Oatmeal, 8 ounces	150	5	3	25
Egg whites, 2 stirred into oatmeal	20	6	—	—
1 rice cake with peanut butter (1 1/2 tablespoons)	218	8	14	15
Dates, 1/4 cup (about 5 whole dates)	137	1	—	33
Totals	*725*	*60*	*19*	*78*

9:30 p.m.: **Multivitamin and -mineral supplement; Omega Stak, 2,000 milligrams**

	Calories	**Protein**	**Fat**	**Carbohydrates**
Meal replacement, such as Muscle-Link's Muscle Meals*	310	40	11	11
Apple	88	—	—	22
Totals	*398*	*40*	*11*	*34*

Noon	**Calories**	**Protein**	**Fat**	**Carbohydrates**
Roasted chicken, 6 ounces	232	40	8	—
Broccoli, 6 ounces	45	4	—	8
Rice, 1 cup	124	4	—	27
Totals	*401*	*48*	*8*	*34*

4 p.m.: **PS (cortisol-control compound, such as Cort-Bloc), 400 milligrams; Omega Stak, 2,000 milligrams; Ribose Size, 2.2 grams**

Meal replacement, such as Muscle-Link's Muscle Meals*	310	40	11	12

5 p.m.: **Effervescent Creatine Elite, then work out**

6:30 p.m.: **Vitamin C, 500 milligrams, Vitamin E, 500 international units Beta-carotene, 20,000 international units; Ribose Size, 2.2 grams**

	Calories	**Protein**	**Fat**	**Carbohydrates**
Protein drink, such as Muscle-Link's Pro-Fusion mixed in Orange juice, 3 cups	200 312	40 3	2 —	5 75
7 p.m.:				
Cottage cheese, 6 ounces	162	22	6	5
Peanuts (handful)	110	5	8	2
Totals	*784*	*70*	*16*	*87*

10:30 p.m.: **PS (cortisol-control compound, such as Cort-Bloc), 400 milligrams; Omega Stak, 2,000 milligrams**

Protein drink, such as Muscle-Link's Pro-Fusion*	200	40	2	5
Grand Totals & Macronutrient percentages	***2,818***	***298 42%***	***67 22%***	***251 36%***

Note: When you use GH Stak or AnaVol-R before bed on an empty stomach, move your 10:30 p.m. protein drink to noon, add it to that meal, and take your PS and EFA supplements with your 7 p.m. meal.