Protein – An Abcbodybuilding Research Initiative – Practical Applications

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The following faq / summary of protein research is based on an in-depth publication on protein which can be accessed by clicking here.

What is the optimal amount of protein that should be consumed each day?

With all the research that has gone on, it appears that this question may be a bit too simplistic. I say this because X amount of protein consumed in a day can create a totally different response when the timing, pattern, and type of protein are considered. There are far too many variables to develop one optimal set amount of protein.

What we can do is give some general guidelines. In essence much of the research is based on nitrogen balance techniques. Protein is made of 16 % nitrogen. Therefore if the amount of nitrogen lost is equal to the amount of nitrogen consumed from protein, then an individual's needs are said to be met. Because bodybuilders are concerned with growth, they are more interested in the amount of protein that optimizes growth and performance. When the amount of nitrogen retained is greater than the amount lost then an individual is said to be in a positive state of nitrogen balance, and assumed to be in a state favorable to muscle growth.

A number of studies have analyzed the amount of protein needed and their data can be summed up as follows.

1. The general consensus for protein needs for strength athletes ranges from 1.2-2.2 grams of protein per kilogram of bodyweight daily.

2. A great deal of evidence has shown that protein intakes beyond those required to obtain nitrogen equilibrium increases the rate at which protein is oxidized (used as fuel). However, those same studies indicate that these excess protein intakes increase the retention of nitrogen and place an athlete in a more anabolic environment. As a review, Tarnopolsky and colleagues (1992) found that when bodybuilders were administered 0.8, 1.4, and 2.4 grams of protein per kg of bodyweight that nitrogen balance was negative in the low protein condition (-2.4 g of N per kilogram kg), and increased from moderate (0.7 g N) to high (3.8) protein conditions. This same trend has been seen in a number of studies.

3. Finally a number of studies have shown that very high protein intakes produce greater gains in muscularity and strength than lower protein intakes.

I suggest a *minimum* of 1.8-2.2 grams of protein per kilogram based on the studies I have reviewed. This works out to a minimum of roughly 1 gram of protein per pound of bodyweight daily.

Is there evidence that higher protein intakes (> 1.8-2.2) can be beneficial?

While this goes against the general consensus, it can be argued based on increased nitrogen retention from higher protein intakes *(> 1.8-2.2)*, that bodybuilders can benefit from such habits. Further most nitrogen retention studies are based on adequate energy intakes. It is clear that when an athlete is dieting that their protein needs increase notably. For example, the bodybuilders in the Tarnopolsky et al. (1992) study consumed nearly

5, 000 calories daily and still were calculated to need a minimum of 1.8 grams of protein per kg of bodyweight to reach nitrogen equilibrium. Had they been consuming a lower intake of calories, their protein needs would have most likely increased, as has been documented in a number of studies.

Further, endurance exercise adds to the oxidation rates of proteins. As an illustration Consolazio (1978) found that 2.8 $g \cdot kg^{-1} \cdot day^{-1}$ of protein produced greater nitrogen balance and lean body mass gains then 1.4 $g \cdot kg^{-1} \cdot day^{-1}$ for 40 days in a combined resistance training and endurance program.

It is critical to understand that studies have not been done in athletes training with resistance exercise and or cardiovascular work up to three-four hours daily. If 1.8 grams per kg was needed in the Tarnopolsky et al. (1992) study for 75 minutes of training, it may be increased with two daily sessions.

Finally, evidence also suggests that training twice daily enhances overall protein synthesis in an additive fashion, thus allowing the athlete to greatly increase their capacity to utilize protein.

My thoughts are perhaps best summarized by Wolfe (2000), who is arguably the top researcher in the world on protein for athletics:

> "our results, along with virtually all data in the literature on the topic, suggest that increasing AMINO ACID intake will increase muscle mass, with all other variables remaining constant. Whereas this concept runs counter to popular perception, real-life examples abound in obese individuals who have significantly elevated muscle mass despite living sedentary lives. Thus, it is likely that increasing AMINO ACID intake in accord with the principles discussed above to optimize effectiveness will promote muscle anabolism, whether in depleted individuals such as the elderly or in active athletes trying to increase muscle mass. *The exact nutritional approach will determine the extent of anabolic response(emphasis added).*"

Should I eat slow or fast digesting proteins?

Digestion rate has been demonstrated in a number of studies to effect both muscular protein synthesis and breakdown. Essentially, the overall effect which determines whether you gain muscle tissue or lose muscle tissue is centered around whether or not protein synthesis exceeds protein breakdown.

There are a number of problems with studies that have been conducted. First, many of the studies have compared whey protein to casein as representatives of fast and slow digesting proteins respectively. Whey protein has a higher quality of protein

than casein as determined by its essential amino acid profile. In particular it is higher in leucine content. Leucine is thought to serve as a signaler molecule for the quality and quantity of protein intake, and is a potent stimulator of protein synthesis. To control for this, studies generally give more casein protein than whey. For example Boirie and colleagues (1997) gave individuals 43 grams of casein and only 30 grams of whey. While they both had the same leucine content, the amount of protein served was greater in the casein condition, which certainly can confound the results.

Fortunately recent studies have investigated what happens when both whey and casein contain the same amount of protein. The other problem is that a number of studies have measured whole body protein synthesis. But this does not differentiate between muscular protein synthesis, and say protein synthesis in organs such as the liver. Again however, there have been studies which correct for this. Overall, the evidence is strong enough to tease several trends out of the background noise of confounding variables. Here is the general consensus of what studies suggest:

Slow vs. Fast digesting proteins when taken alone

1. Fast digesting proteins raise protein synthesis to a greater extent than slow digesting proteins. For example, 30 grams of whey raised whole body protein synthesis by 68 % compared to only 34 % in 43 grams of casein. The rationale is that Essential amino acids serve as both building blocks for muscle tissue, as well as signaling molecules which trigger protein synthesis. Studies suggest that up to a point, the higher the blood levels of amino acids are, the higher protein synthesis will be stimulated. Because whey digests rapidly, plasma amino acid levels rise rapidly and to a greater extent than casein, which rises slowly.

2. Slow digesting proteins lower protein breakdown, while a fast digesting protein does not have these properties. The rationale is that an increase in amino acid levels must occur for a long enough time, or it cannot exert its anticatabolic effects. Whey protein increases amino acid concentrations rapidly, but also falls rapidly. In contrast casein raises amino acid levels slowly and remains elevated for a while.

3. When both proteins taken alone are compared over a seven hour period, casein produces greater whole body protein balance than whey. The problem is, unless you are going to sleep, you are not waiting seven hours before your next meal! And if you are extremely serious about growth, you may not even wait that long during a nights sleep.

Slow vs. Fast digesting proteins when taken with carbohydrates and fats

1. In short, when taken with carbohydrates these results reverse. Generally the addition of other macronutrients decreases protein breakdown when taken with whey, but not to a great extent with casein. While additional nutrients slow digestion, whey still rises more rapidly. Further, the addition of carbohydrates does not greatly affect protein synthesis. Therefore, when combined with a carbohydrate, a fast digesting source of protein such as whey appears to be more anabolic. This has also been supported in a study which compared an essential amino acid / carbohydrate supplement and a meal with casein and other nutrients and their direct effect on muscular protein synthesis. Both had the same amount of essential amino acids (15 grams), yet the supplement produced a markedly higher anabolic response. The rationale was that the fast digesting amino acid source increased

blood amino acid levels so rapidly, that it decreased the efficiency with which other organs like the liver could take up the amino acids, leaving more available for muscular protein synthesis.

In summary, it appears that when a single meal is administered with carbohydrates that a fast digesting source may be desirable. However, when administered without carbohydrates a slow digesting source may be more desirable. This would suggest that before bed would be an excellent time to take a casein containing meal, such as cottage cheese. Namely because the meal before bedtime is typically lower in carbohydrates, to avoid fat deposition.

What is the optimal pattern of protein digestion?

Because bodybuilders eat numerous times within a single day, a seven hour period of food abstinence, when comparing digestion rate is highly improbable outside of sleep, and therefore not relevant to our waking hours. This is why it is important to address the pattern of digestion of protein intake.

The pattern of digestion simply means how an individual consumes their protein throughout a day, and what sources are utilized during this time zone.

There are a few key points to understand when considering the pattern of digestion.

1. An increase in extracellular amino acid levels triggers protein synthesis, while a decrease lowers protein synthesis, despite absolute concentrations. What I mean is this is if your amino acid levels rise 250 %, and then fall to 150 % above resting levels, protein synthesis will most likely lower to basal levels again. However, if you raise amino acid levels at that point, you will get another increase in protein synthesis.

2. The machinery which increases protein synthesis goes refractory when amino acids are raised and held at a constant rate for an extended period of time. For example, in studies in which authors increase blood amino acid levels through intravenous infusion, and maintain those levels at say 200 % above resting, after 2 hours protein synthesis will return to resting levels. The system may act on some form of negative feedback.

3. In response to this, a number of scientists have suggested that continually consuming slow digesting proteins can mimic intravenous infusion, and though amino acid levels are risen for hours on end, cause the system to lower protein synthesis. However, a fast digesting protein source, like whey, or essential amino acids will rapidly rise, and possibly fall within 1-2 hours.

4. Studies show that with fast digesting proteins or essential amino acids, that a similar anabolic response will occur when they are delivered 1 hour apart. So let's say that you consumed 15 grams of EAAs at 12:00 right after working out, and then again at 1:00. If at 12:00 protein synthesis increased by 50 %, you would most likely get the same response an hour latter. The rapid rise in amino acids and drop, may keep the system from lowering protein synthesis in response to continually maintaining a similar amino acid concentration.

5. Rises in protein synthesis throughout the day are additive in nature. This means

that if you normally synthesize X amount of proteins, and working out increases protein synthesis by Y amount, then total protein synthesis for the day would be X + Y. If you then consumed 2 extra essential amino acid drinks throughout the day, each of which increased protein synthesis by Z amount (2Z), then protein synthesis would be X + Y + 2Z. Cool ha!? This means that you can take advantage of rapid increases in amino acids.

Overall suggestions. My overall suggestions are summed by a recent study. In the study they gave participants their normal 3 meals a day, and then added 3 servings of essential amino acids combined with carbohydrates between meals. Here is what it looked like

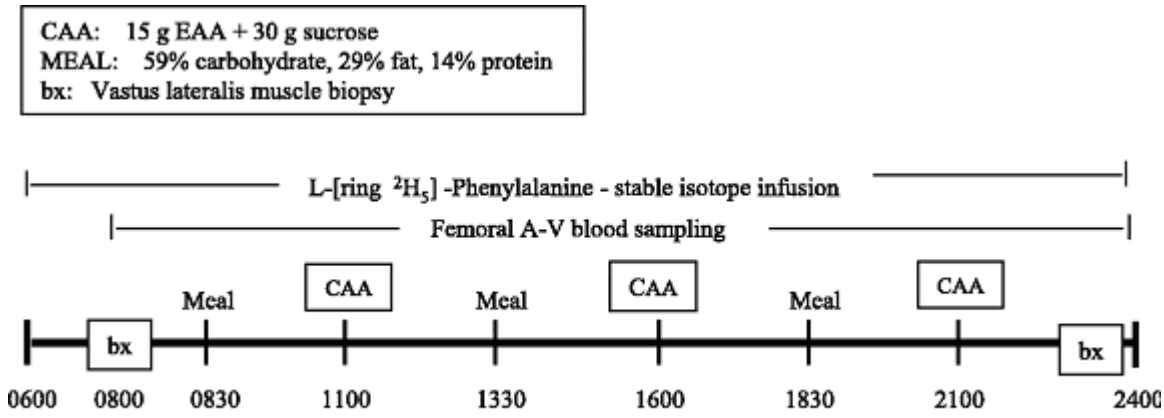

Figure 6 - Meal schedule with added CAA supplement. From Paddon-Jones et.al.(2004)

They found that protein balance increased tremendously compared to the anabolic response of the participant's normal meals. Therefore my overall suggestion is to consume a minimum of 3-5 of your normal meals with normal whole food proteins. Then, the rest of your meals may optimally come from fast digesting proteins for a minimum of three protein shakes. Finally before bed time consume a casein containing protein source such as cottage cheese. This adds up to a minimum of 7 meals, and does not include the pre workout amino acid shakes.

I will outline the meal plan shortly. But the point is simple. If you continually consume slow digesting proteins, you may stunt protein synthesis. The above is a sample of a minimal game plan. Below is a hardcore sample with a bodybuilder who trains up to two times daily

Extremely Hardcore Sample Plan

Overall game plan: To spike protein synthesis in an additive fashion throughout the day. To do so you will need several servings of fast digesting sources of protein.

Meal 1 – 6:00 in the morning
Carbohydrate – to suppress protein degradation
Fast digesting source of protein – to spike protein synthesis

Supplement - 7:00 –
Essential amino acids, and glutamine - Increase extracellular amino acid concentrations,

7: 30 – Begin workout – The workout will increase blood flow to working muscles, combined with the increased extra cellular amino acid levels, an incredible delivery of these vital substrates will be delivered to your muscle tissue.

Meal 2 - 8:30-9:00 – End of workout –

Fast digesting carbs – depress protein degradation
Glutamine, and whey protein – Blood flow is still severely increased to muscle tissue, and will have an additive and possibly synergistic effect when combined with a rich supply of amino acids.

Supplement - 10:00 – 10:30

Consume a small fast digesting protein shake or Essential amino acids to further spike protein synthesis in an additive fashion to the last meal. Protein synthesis can be seriously increased with a serving as small as 6-15 grams of Essential Amino acids, or 20-40 grams of whey.

Meal 3 – 11:30 - Normal Meal –
Mixed protein sources from various meats. – You are probably tired of eating for what seems like every other minute! So give yourself a break, have a normal meal, and don't worry about eating for 2 to 3 hours (no more than three!)

Meal 4 – 2:00 to 2:30 - Faster digesting sources of protein like egg whites and super lean meats (an omelet is great) so that the fat does not hinder digestion.

Meal 5 – 4:30 – Mixed protein sources from various meats

Supplement – 6:00 – Essential amino acids and glutamine

6:30 – Train

Meal 6 - 8:00 – Post workout shake, in smaller quantity then earlier workout

9: 00 - Supplement – small serving of whey or EAAs

Meal 7 - 10:30 – Cottage cheese, broccoli, glutamine – Lower overnight protein degradation

Wake up in the middle of the night – Turn over throw down a casein containing supplement like pro score, milk, or casein and go back to sleep!

Sleep and start over again.

The above diet is only concerned with protein sources. I only discussed the carbohydrate source with breakfast, post workout, and before bed time as it is not the primary concern of this article.

What about the timing of protein intake?

Timing of post workout nutrition.

Nutrient timing is a huge topic in exercise nutrition (For a thorough analysis of post workout nutrition timing, readers are referred to Knowlden (2003, A Scientific Investigation into the Rationality of Post Workout Carbohydrate Consumption). And rightfully so. In essence the way you time the consumption of a given nutrient has tremendous effects on the anabolic effect of that nutrient. As an example, Dr. Esmark and colleagues (2001) compared consuming a protein supplement immediately after exercise or after a two hour delay. It was found that the group that consumed the drink immediately after exercise increased muscle mass, where as the delay group had no significant increases in muscle tissue. Similarly Levenhagen et al. (2001) found that delaying a protein supplement for 3 hours resulted in a net decrease in protein balance, where as the immediate condition increased protein balance. And protein synthesis was 3 times greater in the early condition than the late condition!

There are a number of reasons for these findings such as blood flow differences. Blood flow is greatly enhanced after exercise to the working musculature, and blood is shunted away from other organs. This results in a greater delivery of amino acids to muscle tissue, and a lower percentage of amino acids being taken up by splanchnic tissues such as the gut. The timing of the post workout drink should be immediately after training, so as to take advantage of this primed anabolic environment.

How should I time my pre workout nutrition?

During exercise the muscles which are ferociously working need a greater supply of energy and oxygen. In fact, the percentage of blood delivery to working muscles can increase by 80 %! Pre workout nutrient timing takes advantage of this occurrence. You see, by administering EAAs 30-45 minutes before a training session, the trainee will (A) have a heightened supply of the nutrients critical for muscle repair and (B) deliver those nutrients to the muscle at a rate much greater than could occur at rest.

This was recently studied at the University of Texas medical branch, by a group of scientists who found that consuming a supplement containing EAAs prior to exercise increased blood flow up to 324 % during exercise, in comparison to only 200 percent for those individuals who did not consume the drink. If that wasn't enough, the exercisers increased amino acid deliver to the leg by 650 %, leading to a much greater repair of the working muscle tissue.

Again, the rationale is based on combining the effects of increased blood flow to the musculature and enhanced amino acid availability.

Which is better and what should I have, a pre workout or post workout meal?

This is actually a common question. However, to me, asking this question is similar to asking " What is better, lunch or dinner?" In reality, you should eat both meals. Similarly, both pre and post workout meals are vital to an athletes success. Blood delivery is increased when training, so you will want to have a source of amino acids prior to training. In fact, studies show that normally a bodybuilder is in negative protein balance while training, this is because protein synthesis has little change during the exercise session, but protein degradation increases, leading to a net loss of muscle tissue. Supplementation prior to exercise changes this situation.

However, after working out muscle blood flow is still increased, and consuming another meal is critical to taking advantage of this anabolic window (I would again refer you to Knowldens (2003, 2004) work on the (The Window of Opportunity & the Rationality of Post Workout Carbohydrate Consumption). Further, as was discussed previously studies clearly show that consuming an amino acid supplement one hour apart results in similar anabolic responses.

In summary, approximately 30 minutes before training an athlete should consume an essential amino acid based supplement, or at least a fast digesting source of protein such as whey. After resistance exercise bodybuilders should consume a rapid digesting source of carbohydrates and proteins as described by Knowlden (2003, 2004, also see Wilson, G. 2003, Dextrose, Maltodextrin, and Sodium an In Depth Analysis).

What is the difference between low carbohydrate or high fat diets on the sparing of muscle tissue?

This is an interesting topic. Earlier studies indicated that carbohydrates spared muscle proteins to a higher extent than fats. However, current evidence suggests that they both have similar muscle tissue sparing effects. What I mean is this: carbohydrates and fats are both sources of energy. When dietary energy provision is low, the body will breakdown proteins at a heightened extent for energy. Therefore a high provision of dietary energy lowers this effect.

Diets which are lower in carbohydrate and higher in fats spare muscle proteins similarly to carbohydrates. Further, both of these macronutrients have indirect anabolic effects on muscle tissue through the stimulation of hormones. Carbohydrates primarily stimulate insulin, which is known to hinder protein degradation and increase protein synthesis if amino acid concentrations are maintained, and specifically when insulin levels are very high such as after exercise. Fats, particularly saturated fats, stimulate anabolic hormones such as testosterone.

In this context, it is important for athletes to provide some nitrogen sparing energy source with meals. When meals are low in carbohydrates they should be higher in fats, and vice versa.

If this is true, then why do I feel like it's harder to maintain muscle tissue when low

carbohydrate dieting?

Recently my colleague Gabriel Wilson and I did an extensive review on factors involved in maintaining performance. The evidence kept pointing to the same variable → Intensity. If you lower intensity adaptations in strength and muscle size appear to decrease proportionally. Because carbohydrates are the main source of energy for hypertrophy inducing sets (8-12 repetitions), bodybuilders on low carbohydrate diets have a hard time maintaining the intensity of the stimulus, and therefore deadaptation occurs.

Further, insulin is a potent hormone for enhancing protein balance, which is necessary for muscle growth. All in all, if you want to stimulate an adaptive response, you must expose the system to greater and greater stimuli. In this context, carbohydrates appear to play a critical role.

What is the interaction between carbohydrates and protein in terms of insulin release?

They appear to work synergistically. Meaning carbohydrates and protein combined stimulate insulin secretion to a greater degree than when consumed alone.

How is protein quality determined?

There are several ways to determine the quality of a protein. But, let's just sum it up and say that most are based on the essential amino acid profile of the protein in question. As you know, there are 20 amino acids, 11 of which can be produced by the body (non essential), and nine of which cannot (essential)! Just one missing essential amino acid, and an individual can enter into serious negative nitrogen balance, if they were to only consume protein from that source.

Does protein quality have an effect on muscle growth?

Absolutely! This has been demonstrated in a number of studies. For example Phillips et al. (2005) administration either milk protein or soy protein after participants trained with weights. After 12 weeks of resistance training, it was found that the group that consumed milk protein had greater muscle mass than the placebo group who only had maltodextrin. However, there was no difference between the soy and maltodextrin group!

Generally animal based products are the highest quality proteins. These products consist of meats such as beef, and chicken, as well as egg products, and milk based products. One study conducted by Campbell and colleagues (1999) found that subjects who consumed a meat based protein diet, compared to a vegetarian based protein diet, gained lean body mass, and lost body fat in a 12 week resistance trained program. However, the vegetarian group lost muscle tissue and gained fat! For vegetarians who cannot consume meat, an alternative would be whey protein, and casein based products.

There are a number of reasons why higher quality proteins stimulate a greater degree of growth. Two of the most important are as follows:

1. Essential amino acids act to stimulate protein synthesis directly. Meaning as their

extra cellular concentration increases protein synthesis increases. Non essential amino acids do not have this effect.

2. Proteins that are deficient in one or more of the essential amino acids, appear to increase protein synthesis in the splanchnic tissues such as the liver, and depress protein synthesis in muscle tissue. The opposite occurs for proteins with a high profile of essential amino acids. One of the reasons is that a number of the essential amino acids, particularly the branched chain amino acids are poorly absorbed by the liver and other splanchnic tissues. So they have a much greater availability for muscle tissue!

Should I combine proteins to increase their quality?

In short, yes! Complementary proteins is a notion popularized by vegetarians. For example grains are deficient in lysine, but high in methionine, while legumes are high in lysine, and low in methionine. By combining the two you complete the amino acid profile. Studies show that complementary proteins should be eaten at the same meal, or you will have additive effects of ingesting multiple incomplete protein meals, as opposed to additive effects of complete protein meals.

The concept of complimentary proteins can also be used for meat eaters. Typically proteins such as steak, and chicken, are higher in some amino acids than others. By combining the two proteins in a single meal, you increase the quality of that meal.

In summary, I suggest consuming the majority of your proteins from meat based products. Further it is optimal to combine protein sources. For example, an egg white omelet with lean chicken is excellent. Another example is lean turkey and steak in the same meal.

Complementary proteins should be consumed in the same meal.

What is the point of protein supplements when you can just consume protein from whole foods?

There are numerous reasons. First, protein supplements such as whey are extremely cheap relative to whole meats. But, what is interesting is that they may be somewhat more anabolic. Fast digesting proteins like whey, and Essential amino acid supplements, like Champion Nutrition's Essential Amino acid shooter have been shown to be more anabolic then a larger meal containing the same amino acid profile! But why would two meals containing the same essential amino acid profile differ in their anabolic response? Padon-Jones et al. (2005) suggests that the faster digestion of the protein supplement may decrease the efficiency of uptake of amino acids in splanchnic tissues, and leave more available for muscle tissue.

Further, consumption of an essential amino acid supplement, with high doses of leucine has been shown to be more anabolic than a normal protein supplement. Leucine is known to both increase protein synthesis as well as increase the sensitivity of muscle tissue to insulin's anabolic effects!

How much protein can you consume in a single serving?

Really I think the question is what is optimal? Well, it appears that increasing extra cellular EAA levels will directly stimulate protein synthesis proportionally to the

increase in a curvilinear fashion. This means that increasing EAAs early on raises protein synthesis in an almost direct relationship as amino acid levels rise up to 80%. After this, protein synthesis continues to rise, but in a slower fashion. However, the point at which an increase in amino acids stops stimulating protein synthesis is unknown.

What we do know is that there appeared to be no difference between 20 and 40 grams of essential amino acids, which in a normal protein would amount to being no difference between 40-50 grams of protein to about 80 grams of protein in one serving. However in a study by Dangin and colleagues (2003), they found that increasing protein intake with whey from 22 to 33 grams markedly increased protein synthesis. However, it should be noted that this will vary with bodyweight. For example, the protein intake I mentioned was an average of 33 grams in the high condition. But in reality the authors prescribed to each participant 0.48 grams of whey protein per kg of bodyweight. Therefore a roughly 200 pound man, would have consumed 43 grams of protein.

Therefore the optimal level of protein may hover between 0.48 grams of protein per kg of bodyweight per meal (it could be less or it could be more). Further, this optimization appears to be based on the essential amino acid profile. When consuming essential amino acids, studies suggest that >= to 20 grams should be sufficient.

It should be emphasized that the above recommendations are limited and that more studies will need to be conducted to see what is truly optimal.

Conclusions

I must say that this series has been an experience. Protein consumption is an extremely complex subject. Fortunately a number of great scientists have conducted exquisite research relative to a great number of variables effecting the anabolic properties possessed by a given bolus of protein.

I could go on and on. But suffice it to say. If you apply the principles laid out in this series you will become leaner, fuller, and heck freakier as well!

Yours in Sport

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