# The Window of Opportunity—Layman's Version (Semi-Technical)

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## The Importance of Post Exercise Nutrition

During a high intensity, high volume workout, various nutrients are depleted from the body, and catabolic hormones are also elevated. Both of these factors are contraindicating to muscular hypertrophy and performance. The goal of a quality post workout shake is to help replenish these fuels lost from physical activity, and abate catabolism (muscle, and nutrient breakdown), and conversely, promote anabolism (muscle growth, and nutrient replenishment). In order to effectively do this, we must understand exactly what nutrients are lost during exercise, and what types of foods and supplements need to be consumed, in order to maximally replenish these nutrients and abate catabolism, while concomitantly promoting anabolism. Therefore, this paper is dedicated to discussing these issues.

This paper is based on several articles composed in JHR, including The Window of Opportunity and A Scientific Investigation into the Rationality of Post Workout Carbohydrate Consumption. If the reader is interested in learning more about this topic, and also, following up on the references mentioned, they are referred to study those articles, and others which shall be mentioned throughout this paper.

## Water and Electrolyte Replenishment

Hydration is the maintenance of plasma volume (the water portion of blood) in the body. This is done by consuming adequate supplies of water throughout the day. Evidence suggests that a dehydrated muscle is a catabolic muscle, and performance will likewise, suffer from dehydration. Therefore, maintaining myofibril hydration is off the utmost importance to the serious athlete.

Another important variable to consider is electrolyte replenishment. Electrolytes are substances which can dissociate into ions in water. Solutions of electrolytes therefore conduct an electric current and can be decomposed in a solution (electrolysis). Of particular interest to athletes, is replenishment of the electrolyte sodium. Sodium constitutes 93% of the cations (positively charged molecules) in the body, making it by far the most abundant member of this family.

Incidentally, drinks absent or containing little amounts of sodium post-exercise dilutes blood plasma, increases urine production (decreased fluid retention), and lowers osmolarity. This further inhibits the thirst mechanism, and delays rehydration [8, 26, 32, 21, 22], which as previously discussed, is not conducive for growth, or performance.

For example, an experiment was performed on six men following strenuous exercise in the heat [23]. Within 30 minutes after, they ingested one of four drinks (all with 2045 ml of water) with sodium concentrations of 2, 26, 52, and 100mmol per L of water, respectively. Those who had 2mmol of sodium excreted almost 800 ml of

water 1.5 hours later and almost 1400 ml 5.5 hours later. The best results came with 100 mmol of sodium. Only 300 ml of water was excreted in the first 1.5 hours, and 500 in 5.5 hours—which is less than what those who had little sodium excreted in 1.5 hours!

Typically, a well-assimilated athlete will loose .5L - 3L of sweat during each hour of exercise. On average, an athlete looses 1-1.5 liters per hour. Higher intensity exercise results in increased sweat loss. Humidity, heat, and other weather-related factors will result in increased sweat secretion, as well. Lastly, every liter of sweat contains a whopping .6 grams of sodium. This is vital information to consider, when designing an optimal post-workout shake.

Thus, a proper post workout solution will want to contain both proper amounts of water and sodium. Recommendations for proper water and sodium replenishment will be discussed further on.

If the reader is interested in studying the importance of water and sodium further, or studying the references cited here, refer to Wilson G. (2003), Sodium - A comprehensive Analysis and Effect of Plasma Volume on Myofibril Hydration, Nutrient Delivery, and Athletic Performance.

## Glycogen Replenishment

Glycogen is the storage form of the carbohydrate glucose. Evidence suggests that as exercise intensity increases, your body has a greater reliance on carbohydrates; particularly, muscle glycogen. During high intensity exercise (exercise above 85% of your vo2 max) evidence suggests that 75% of your fuels come from carbohydrates, 80% of which is supplied by muscle glycogen (see, Direct Comparisons of Fuel use during Low, Moderate, and High Intensity Exercises for references on this). Accordingly, there is a direct correlation between glycogen depletion, and rate of perceived exertion, as well as decrements in performance.

Since glycogen stores are limited (the typical human can store 400-625 grams of muscle glycogen and about 100 grams of liver glycogen (Inouye, 2006)), and high intensity exercise (such as resistance training) is highly dependent on glycogen stores, it is clear why another vital component of post exercise nutrition, is glycogen replenishment.

In this context, studies have found that the athletes who consume a combination of easily digested carbohydrates and proteins post exercise, doubled glycogen synthesis rates in comparison to a carbohydrate only meal (Van Loon et al., 2000). Another study found that athletes who consume a combination of carbohydrates and easily digested whey proteins immediately post exercise lengthened their time to exhaustion on a subsequent workout by 55%, and had a 128% greater glycogen storage in comparison to a carbohydrate only beverage (Williams et al., 2003)! Again, for references, refer to the post workout nutrition articles mentioned above.

Therefore, athletes will want to consume both carbohydrates and proteins post exercise, to optimize glycogen replenishment.

Concerning which carbohydrates to consume, evidence suggests that a 50/50 combination of Dextrose and Maltodextrin is optimal for glycogen replenishment. For the theoretical rational behind this recommendation refer to, Dextrose, Maltodextrin, and Sodium an In Depth Analysis as well as, Pre Contest Week - An In Depth Analysis.

This will want to be accompanied by an easily digested, high quality source of protein. For these purposes, Whey Protein is optimal to consume post exercise.

## Abating Catabolic Hormones

All body builders have a sworn mortal enemy—cortisol. This hormone acts to breakdown muscle tissue, and creates a catabolic environment, contrary to growth.

The question is: what is the effect of exercise intensity on cortisol?

Davies (1973) examined the effect of duration and intensity on plasma cortisol levels. It was found that as duration and intensity increased, cortisol increased (though there is a threshold, and this is threshold is dependent on blood glucose levels. Refer to Slow Acting Hormones and their Role in Fuel use during Exercise for more information).

Other hormones, such as glucogon and catecholamines, which also are catabolic hormones that work to breakdown nutrients, are also released linearly with exercise intensity.

With this in mind, these hormones are collectively referred to as counter regulatory hormones, because they promote the release of glucose from muscle, as well as the hepatic system (liver).

Evidence suggests that the most effective way to abate these catabolic hormones, is to consume an easily digested carbohydrate, that will rapidly increase the amount of glucose in the blood stream, and also, stimulate the hormone insulin, which is an anabolic hormone that acts to stop the catabolism of nutrients, while concomitantly facilitating the anabolism of several nutrients, such as the formation of glucose, into muscle glycogen. This process is further augmented when stacked with an easily digested source of protein, which as discussed above, has a synergistic effect with carbohydrates on glycogen replenishment. Proteins also increase the insulinogenic response of a carbohydrate meal, further attenuating catabolism.

## Protein Synthesis and Degradation

Skeletal muscle protein synthesis can be defined as the formation of whole muscle proteins, from individual amino acids. In other words, it means muscle growth! Conversely, protein degradation can be defined as the breakdown of proteins, into individual amino acids and peptides. In other words, it means muscle loss.

With this in mind, while protein synthesis is elevated up to 48 hours following an exercise session, protein degradation is also increased; resulting in a negative protein balance ***if*** additional nutrients are not supplied (Phillips et al., 2005). Furthermore, in order to take advantage of these elevated levels of protein

synthesis, an adequate amount of nutrients will need to be provided. In this context, post workout amino acid feedings are critical to muscle protein accretion (growth). For instance, Biolo, Tipton, Klein, and Wolfe (1997) investigated the effect of infusing amino acids at rest and after exercise. They found that while amino acid concentrations increased similarly in both conditions, that muscle blood flow was 64% greater after exercise than at rest. Further this corresponded with a 30-100 % increase in amino acid transport when compared to rest. There was also a greater increase in skeletal muscle protein synthesis after exercise than at rest (291 % vs. 141 %).

Studies indicate that consuming protein itself is generally responsible for enhancing protein synthesis; while carbohydrates play an intricate role in decreasing protein degradation. The role carbohydrates play in protein synthesis is in debate. However, it appears that when easily digested carbohydrates are accompanied with proteins, the enhanced insulinogenic effect from these nutrients may directly enhance protein synthesis. Either way, to optimize protein synthesis, and decrease protein degradation, a combination of proteins and carbohydrates is optimal.

For more information on protein, and relevant references, refer to The Ultimate Protein Guide! You can also read our peer reviewed manuscript on protein here, http://www.abcbodybuilding.com/proteinaccepted.php

## Nutrient Timing—The Window of Opportunity

Studies indicate that there is a short window of opportunity post exercise, in which glycogen replenishment and protein synthesis is optimized. Therefore, if athletes wait to long to consume their post workout shake, this window of opportunity will be gone.

### The Window of Opportunity and its impact on Glycogen Replenishment.

Evidence is clear that if carbohydrates are not consumed in a timely manner post exercise, glycogen replenishment is hindered.

For instance, Ivy et al. (1988) investigated the time of ingestion of a carbohydrate supplement on muscle glycogen storage post exercise. Participants consisted of 12 male cyclists. The apparatus consisted of a cycle Ergometer. Two experimental conditions were utilized. In the first condition participants exercised continuously for 70 minutes at 68 % V02 max, which was interrupted by 6, 2 minute intervals at 88 % V02 max. Upon completion of exercise, participants consumed a 25 % carbohydrate solution. In condition two, the same exercise protocol was used. However, the CHO drink was delayed for 2 hours.

Comparison of muscle glycogen resynthesis among conditions found that the rate of glycogen storage was greater in the immediate condition following the induction of the CHO solution than in the delayed condition by 45 %. Therefore, a slower rate of glycogen storage occurred in the delayed condition, even though insulin levels rose significantly.

This is one of countless examples showing why the window of opportunity must be met.

For more information on this and references, refer to Pre Contest Week - An In Depth Analysis.

**The Window of Opportunity and its impact on Performance, Protein Synthesis and Muscle Growth**

Similarly to studies on glycogen replenishment, studies clearly indicate that if protein is not consumed immediately upon cessation of exercise, performance, protein synthesis, and ultimately, muscular hypertrophy, will be hindered.

The importance of having a fast digesting protein right after a workout was demonstrated by Esmarck et al. (2001), who investigated the effect of immediate and 2 hour delay feedings of protein on muscle hypertrophy and strength over a 12 week period of resistance training in elderly males. An oral supplement of 10 grams of protein, 7 grams of carbohydrate, and 3 grams of fat was administered. Results indicated that both mean fiber area and quadriceps cross sectional area increased in the immediate protein condition, where as no significant differences were found in the 2 hour delay condition. Both dynamic and isokinetic strength increased, by 46 and 15 %, respectively in the immediate condition, whereas the delayed condition only improved in dynamic strength, by 36 %.

As an additional comparison Levenhagen et al. (2001) administered an oral protein supplement (10 g protein, 8 g carbohydrate, 3 g fat) either immediately (EARLY) or three hours after moderate intensity exercise (LATE). Results indicated that Net balance was significantly more positive during EARLY, compared with LATE, for isoleucine, leucine, lysine, phenylalanine, proline, valine, BCAA, EAA, and NEAA. In fact, while there was a net uptake of BCAA, EAA, and NEAA with the EARLY condition, there was a net release of BCAA, EAA, and NEAA in the LATE condition. Further leg protein synthesis was more than 3 times greater in the EARLY condition than the LATE condition. Finally whole body protein deposition was greater in the EARLY condition than the LATE condition.

Again, refer to the aforementioned protein article for references.

## Tapering the Solution

Research has pointed to increased recovery by intermittent consumption of glycogen synthesis recovery drinks (14, 26). Therefore, we advise tapering the post workout solution over 45-60 minutes. This will help maximize nutrient absorption and decrease fat gain.

For more information on this refer to essay 6 in, A Scientific Investigation into the Rationality of Post Workout Carbohydrate Consumption.

## Supplements

So far, it has been demonstrated that an athlete needs to consume the carbohydrates maltodextrin and dextrose, whey protein, water, and sodium immediately upon the cessation of physical activity. In addition to this, incorporating several other supplements would also be advantageous. The following section will analyze must have, post exercise supplements.

## Chromium:

See: 13 Weeks To Hardcore Fat Burning - The Diet

Muscular insulin sensitivity can be defined as the capacity of the muscle cell to take in and utilize glucose for energy, or for the storage of muscle glycogen. Muscular insulin resistance (a decreased capacity to absorb glucose) will therefore, lead to fat storage, and impaired glycogen replenishment. In this context, Chromium has been found to increase insulin sensitivity and the lack there of will do the opposite. Based on the current literature, we advise consuming a 200-400 mcg tablet of chromium post exercise.

## L-Glutamine:

Glutamine is a conditionally essential amino acid; meaning that under normal conditions your body produces adequate amounts of it. However, under severe stress (such as a vomiting-inducing session of squats), your ability to produce this amino acid falls well short of your bodily needs. For instance, Keast et al. performed a great experiment to examine the effect of exercise on plasma glutamine concentrations. Group 1 consisted of seven randomly selected male athletes who utilized a treadmill at 0, 30%, 60%, 90% and 120% of their VO2 max. The latter group was composed of five advanced male athletes. They performed two gut-wrenching interval training sessions per day for ten days, followed by a six-day recovery period. Glutamine concentrations dropped rapidly from 1244 +/- 121 mumol/L on average to 702 +/- 101 mumol/L after exercise at 90% VO2max ($P < 0.05$) and to 560 +/- 79 mumol/L at 120% VO2max ($P < 0.001$). They concluded that, “Reduced plasma glutamine concentrations may provide a good indication of severe exercise stress.”

Glutamine has demonstrated many, attractive attributes to the athlete, including increase protein synthesis, decreased protein degradation, enhanced hydration, and improved immune function, among other benefits. Lastly, glutamine absorption is maximized when accompanied by glucose and sodium, making post exercise a perfect time to consume this supplement.

Therefore, consuming glutamine post exercise is vital. For more information on glutamine, refer to, See: Glutamine.

## Creatine

The ATP-CP (Phospho-creatine) energy pathway is the first pathway used during high intensity exercise. Studies indicate that supplementing with creatine can enhance this pathway, effectively improving exercise performance. Of further significance to bodybuilders is that creatine also enhances protein synthesis, by increasing myofibril hydration.

Lastly, creatine absorption is optimized when accompanied by sodium and glucose, making post exercise a perfect time to consume this supplement. For more information on creatine, refer to, Creatine Monohydrate Supplementation – A literature Review.

## Anti-Oxidants

A manifold of chemical reactions occur within the body as a result of intense physical training. During both aerobic and anaerobic training, one such reaction is the occurrence of excess and adverse free radical production. Furthermore, concentric and eccentric contractions, which are crucial to exploiting hypertrophy/hyperplasia, appear to enhance this reaction, known as Exercise Induced Oxidative Stress (EIOS).

Apposite antioxidant supplementation has been revealed through an abundant amount of studies to aid in counteracting such negative responses to training. In addition, the post-workout "window of opportunity" has shown itself to be an exceptional timeframe in which to administer anti-oxidant supplementation in direct combat of EIOS.

Exercise induced oxidative stress is a corporal reaction that needs to be counterbalanced during the body's peak time of receptiveness to nutrition.

This phase of the physiques response to extreme physical stress can best be remedied through appropriate post-workout supplementation.

A proper post-workout anabolic cocktail relying on the shuttling effects of insulin and rapid gastric emptying is the ideal atmosphere for anti-oxidant consumption in the effort to combat EIOS.

See: Role of Antioxidant Supplementation in Response to Exercise Induced Oxidative Stress

**Optimal Protein Intake**

Dangin and colleagues (2003) investigated the effects of various slow and fast digesting proteins on protein balance in a single delivered bolus. In their study they compared 22 grams of whey, 33 grams of casein, and 33 grams of whey on protein balance. Each bolus was combined with carbohydrates and fats. The authors found that the 33 grams of whey protein promoted the greatest protein balance in both young and elderly individuals. However, it should be noted that this will vary with bodyweight. For example, the protein intake 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. In the British system, this would be translated to about .22 grams of protein per pound of body weight. Therefore a roughly 200 pound man would have consumed 44 grams of protein.

We therefore, recommend consuming at least 0.48 grams of whey protein per kg of bodyweight post exercise. While LBM may be a better indicator of protein needs, this study used body weight. Therefore, we advise tailoring this according to body weight. While this may result in slightly excess protein needs, that is a better alternative to suboptimal protein dosages. However, for an individual whose body fat exceeds 25%, it may be advantageous to choose a somewhat lower dosage. This will have to be determined by the individual.

Finally, these dosages should remain the same, whether you are cutting, or bulking.

**Optimal Carbohydrate Intake**

Based on the literature, on a bulk-up plan, we advise the amount of carbohydrates consuming 5 grams of carbohydrates per every 10 pounds of lean body bodyweight. Lean body fat would be defined as the bodybuilder's bodyweight after they have subtracted their body fat percentage. So a 200lb man would not necessarily ingest 100 grams of carbohydrates post workout. If his body fat percent were say, 16%, he would instead consume eighty-four grams post workout. This is calculated by taking the body weight of 200 lbs times 16% for a calculation of 32 lbs excess body weight. Subtracting the 32 lbs from the original 200 lbs would allow us to know the lean body weight, which in this case equals 168 lbs.

On a cutting phase we advise consuming 2.5 grams of carbs per 10 pounds of lean bodyweight. The goal here is to consume just enough to suppress cortisol and replenish glycogen stores, while still catering to a calorie restricted diet.

## Summary and Conclusions

The purpose of this article was to demonstrate exactly what nutrients are lost during exercise, and what types of foods and supplements need to be consumed, in order to maximally replenish these nutrients, and abate catabolism, while concomitantly promoting anabolism. Results indicated that the carbohydrates maltodextrin and dextrose, whey protein, water, and sodium should be consumed immediately upon the cessation of physical activity, tapered over 45-60 minutes to maximize nutrient absorption, and avoid fat gain. In addition, the incorporation of the supplements glutamine, creatine, chromium, and anti-oxidants were also found to be advantageous.

Part 2 of this series will give explicit recommendations on post workout nutrition, as well as an easy to use post workout shake calculator. To read this, click Here.

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