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Replacement vs. Replenishment

To fuel successfully, less is better!

This is the keynote article on what constitutes proper fluid, calorie, and electrolyte intake during exercise. Our scientifically and experientially established position is this: replenish your body with what it can comfortably accept instead of trying to replace what your body expends. You must calculate your fluid, calorie, and electrolyte intake in accord with your body's intake mechanisms, and not according to its output. If you follow this principle, you will greatly reduce or entirely avoid bloating, cramping, nausea, vomiting, diarrhea, and bonking. Fueling your body in a way that works with it and not against it not only feels better, it also yields higher quality workouts and improved race results.

Two analogies will help us understand faulty fueling: a barrel and gas tank. Imagine a barrel of water with a tap at the bottom. Open the tap and stick a hose in the top of the barrel, filling it at the same rate that the water flows out the bottom. The input replaces the output. That works fine for a barrel, but our bodies are far more complicated than barrels. The water we drink doesn't go directly to our pores to provide sweat to cool us. Carbohydrates don't go straight down our esophagus to our muscles to provide energy. Instead, we have complex mechanisms that transport, distribute, break down, store, retrieve, and utilize the water and nutrients that we consume. It's impossible just to plug in a hose and re-supply at the rate we expend nutrients and water. If we try to refuel thinking that our body is like a barrel, and all we need to do is measure what comes out the tap and then adjust the input hose accordingly, we'll soon be in big trouble. We'll get oversupplied, disrupt our internal systems, and suffer physiological and performance consequence that range from merely uncomfortable nuisances, like stopping often to pee, to the rare, but fatal case of extreme water intoxication.

The second way to picture faulty fueling is the gas tank analogy. Your car has a gas tank that stores enough gas to run the engine for many hours. You can refill in a few minutes, and you're set for another several hours of drive time. Some people try to fuel this way, but the human body does not come equipped with an internal fuel tank. We do have some storage capacity, such as muscle glycogen and body fluids, but we can't slug down 500 calories and a liter of water in a few minutes and think that we're good for an hour or more of exercise. Our tanks must be external (e.g., water bottles) and we must adjust our intake to our body's intake capacity. We can only re-supply as much as we can process at a time, and that means the right amounts at the right time.

In my first Race Across America (a.k.a. RAAM) in 1988, I found out what happens when one ignores the complex physiology of the magnificent organism that is the human body. I learned the hard way that we cannot come anywhere near to replacing the amounts of fluids, calories, and salt/electrolytes that we expend during intense exercise. Like so many athletes then and now, I fueled my body under the belief that since I was losing "X" amount per hour I needed to consume "X", or I'd bonk. What I didn't take into account—and this is the sad truth with so many athletes today—is that the human body knows that it can't effectively replace the full amount of what it loses right away and that it has numerous built-in mechanisms that make up for the shortfall.

Somehow, I did finish the cross-country race, but trust me, I spent most of the time in miserable discomfort. My crew, dutifully following my demands, gorged me with ridiculous amounts of calories and bloated me with excessive fluids. Common sense might have told me to back off, but stubbornness and the mental numbness of round the clock cycling kept me on the same insane regimen. Thinking I was doing the right thing, I adhered to my plan for the majority of the race. Stomach distress, bloating, and nausea? This was RAAM, where self-inflicted misery is par for the coast-to-coast course. I felt sick to my stomach most of the time, and I gained so much water weight (due to my large salt intake) that my belly darn near touched the top tube when I was down on the drops. That's some serious bloating! My inept fueling protocol was the culprit for all these maladies.

Your body is extraordinarily designed and knows how to regulate itself when it comes to fueling. During prolonged exercise it does need your help, but you must cooperate with your body's innate survival mechanisms. Give your body "a helping hand" by providing it with what it can effectively assimilate (instead of trying to replace everything it's losing), and I ***absolutely guarantee*** *that you will feel better during exercise and enjoy dramatic performance improvements.*

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We at Hammer Nutrition consistently deal with many fueling myths, and I'd rate the "replace what you lose" approach as probably the worst offender of all. Many organizations and alleged experts continue to recommend that athletes need to replace what they expend during exercise in equal or near-equal amounts, hour after hour. They cite data such as "you lose up to two grams of sodium per hour, burn up to 900 calories hourly, and sweat up to two liters an hour" to defend their position. Even worse, sometimes they don't give any numeric guidelines, just vague statements like "drink as much as you can." Sadly, far too many athletes fuel their bodies exactly this way, and they get only poorer-than-expected results or a DNF to show for their efforts.

The figures that the "replacement" proponents cite are often valid: a vigorously exercising athlete, especially a big guy, can really expend significant amounts of fluids, calories, and sodium. We don't argue at all with most expenditure figures. However, expenditure just isn't the appropriate measure to guide your fueling. The best guideline is what you can effectively **assimilate**. Don't go by what you burn/lose, but rather what the body can reasonably absorb and process during any given period of time.

Two statements from Dr. Bill Misner represent our position on what proper fueling is all about:

"To suggest that fluids, sodium, and fuels-induced glycogen replenishment can happen at the same rate as it is spent during exercise is simply not true. Endurance exercise beyond 1-2 hours is a deficit spending entity, with proportionate return or replenishment always in arrears. The endurance exercise outcome is to postpone fatigue, not to replace all the fuel, fluids, and electrolytes lost during the event. It can't be done, though many of us have tried."

"The human body has so many survival safeguards by which it regulates living one more minute, that when we try too hard to fulfill all its needs we interfere, doing more harm than good."

What this means is that the body cannot replace fluids and nutrients at the same rate it depletes them. Yes, the body needs your assistance in replenishing what it loses, but that donation **must** be in amounts that cooperate with normal body mechanisms, **not** in amounts that override them. Here's an important fact to keep in mind: at an easy aerobic pace, the metabolic rate increases 1200-2000% over the sedentary state. As

a result, the body goes into "survival mode," where blood volume is routed to working muscles, fluids are used for evaporative cooling mechanisms, and oxygen is routed to the brain, heart, and other internal organisms. With all this going on, your body isn't terribly interested in handling large quantities of calories, fluids, and electrolytes.

Your body already "knows" it is unable to immediately replenish calories, fluids, and electrolytes at the same rate it uses/loses them, and it has the ability to effectively deal with this issue. That's why we don't recommend trying to replace hourly losses of calories, fluids, and electrolytes with loss amounts. Instead, we recommend smaller replenishment amounts that cooperate with normal body mechanisms. We'll discuss this in more detail later in the article.

Fueling variability among athletes

Over the course of two decades, we've had the opportunity to observe the fueling habits (consumption of fluids, calories, and electrolytes) of thousands of athletes. Needless to say, these fueling protocols have varied tremendously. Here are some of the variations we have observed:

ELECTROLYTES: The female winner of a past Leadville [Colorado, US] 100-mile ultramarathon won the event by over an hour (beating most of the men as well) consuming merely one Endurolytes capsule per hour. Her electrolyte profile (done via blood labs) taken before the event was remarkably the same after the event. At the other end of the scale, one triathlete client of ours regularly consumes up to eight Endurolytes per hour in his iron distance triathlons. At six Endurolytes per hour, which is an upper-end dose for most athletes, he cramps or has gastric upset.

FLUIDS: Fluid intake with the athletes we've observed ranges from 12-40 fluid ounces (approx 355-1183 ml) per hour.

CALORIES: Calorie intake also varies considerably, with intakes ranging from 200-700 calories per hour.

With that in mind, of the athletes who have contacted us to report success (no fuel-related, performance-inhibiting problems and consistent energy levels), the following data occur with reliable consistency:

- Fluid intake was under 30 fluid ounces (approx 887 ml)/hour.
- Electrolyte intake was between 3-6 capsules/hour, with 4 capsules/hour being the most often reported dose.
- Energy intake was at 300 cal/hour or less.
- Body weight at finish decreased about 2-3%.

Athletes who suffered poor performance due to fueling-related problems reported consumption as follows:

- Fluid intake was nearly always over 30 fluid ounces (approx 887 ml)/hour.
- Body weight at finish was hyperhydrated with weight gain from 1-2%, or dehydrated at over 3% body weight loss.
- These athletes consumed excess calories, greater than 300 cal/hour, primarily from simple sugared-based fuels, causing stomach shutdown.
- These athletes had high sodium diets. Those who consume that type of diet are predisposed to higher sodium intake during an event than the low sodium purist.
- Ultra distance athletes who suffered cramps, sour stomach, malaise, and/or hyponatremia in the last half of their event often did not train adequately at race-level fluid/fuel/electrolyte dosing, or the athlete used a different fueling protocol than in training. Athletes need to not only train appropriately leading up to their race, they also must test, evaluate, and fine-tune their fueling plan in training prior to using it in a race.

What you should derive from all this is that while there is no "one size fits all" fueling formula, there are some good guidelines in terms of what has been shown to be successful for athletes and also consistent observations (read: fueling errors) noted from athletes who had unsuccessful races.

What does research show regarding replenishment?

This is a suggested comparison showing approximated upper values for what is lost during prolonged endurance exercise to what can be successfully absorbed, replaced, and routed into the energy cycle for the majority of fit, acclimatized endurance athletes:

SUBSTANCE	RATE LOSS/hr	ASSIMILATION RATE
Fluids (ml)	1000-3000 (30-90 oz)	500-830 (17-28 oz)
Sodium (mg)	2000	500-700
Fuel (Carb Cal)	700-900	240-280

Below are the corresponding replenishment values that we have observed for the majority of fit, acclimatized endurance athletes (+/-5%):

SUBSTANCE	RATE LOSS/hr
Fluids	20-33%
Sodium	20-35%
Fuel (Calories)	30-40%

This material was extracted from the following literature:

- Noakes T.D., 2003, **Lore of Running**. Leisure Press. Champaign Illinois. Pages 768-770 29 published and unpublished papers cited on fuels, fluids, electrolyte issues during endurance exercise.
- Moodley D. et al., 1992, Exogenous carbohydrate oxidation during pro longed exercise. The effect of carbohydrate type and solution concentration. Unpublished manuscript in #1 above.
- Sweat Composition in Exercise and Heat. Verde T, Shephard RJ, Corey P, Moore R, 1982, J Appl Phys 53(6) 1541-1542.
- Sweating: Its composition and effects on body fluids. Costill DL, 1977 & 1982, Annals of the New York Academy of Sciences, 301, p.162.
- American Dietetics Association Position Statement
- American College of Sports Medicine Position Statement

As you can see, there is a tremendous difference between what is lost and what can effectively be replenished during exercise.

For calories, only 30-40% of what is utilized ("burned") can be efficiently replenished. Fluids are replenished at a rate of only 20-33% of what is spent, and sodium 20-35%. What's important to keep in mind is that the body is keenly sensitive to this, recognizing its inability to replenish what it loses at anywhere near the rate that it's losing it.

For example, body fat stores satisfy upwards of two-thirds of energy requirements, very easily making up the difference between what is burned and what the body can accept in replenishment. For most athletes, calorie oxidation rate and gastric absorption rate typically allow for no more than 300 calories per hour to be consumed for successful gastric absorption to energy transfer. Consuming greater than 300 cal/hour increases potential for a number of stomach/digestive distress issues.

In regards to body fluid volume and serum sodium concentration, both are controlled to a degree by hormone pathways between the brain and internal organs. As Dr. Misner stated, the body has remarkably complex and efficient "built-in" survival safeguards that very capably deal with the difference between what it loses and what it can accept in replenishment. The various systems involved are complex, but the bottom line is that only a relatively small consumption will keep you going. On the other hand, over-consumption can easily throw the systems out of whack.

Our basic recommendations

Based on what science has shown us, plus two decades of working with athletes, we have determined the following ranges as ideal for most athletes most of the time for maintaining optimum exercise performance:

- Fluids: 20-25 ounces (approx 591-739 ml) hourly
- Sodium chloride (salt): 300-600 mg hourly (3-6 Endurolytes)
- Calories: 240-280 calories hourly

Of course, there are many individual variations that you will need to consider (age, weight, training/racing stress, fitness, acclimatization levels, weather conditions) to determine what works best for you. Some athletes will need less than these suggested amounts, some slightly more. Certain circumstances require flexibility; for instance hot weather and high-impact exercise, such as the run portion of a long-distance triathlon. Hot weather usually means lower hourly calorie intake, a slightly higher fluid intake, and an increased electrolyte intake. High impact exercise such as running does better with roughly 30%-50% lower caloric intake per hour than what you'd consume during a less jarring exercise such as cycling.

All this said, the above-listed figures make good starting point for determining your ideal intakes for varying conditions and circumstances.

Summary

We have been publishing this information for a number of years. Sadly, many athletes continue to listen to "consume what you lose" propaganda, arguing that nutrients and water need to be replaced immediately. This simply is neither true nor possible; fluids, calories, and electrolytes cannot be replaced 100%, or even 50%. As a result of following this flawed advice, athletes continue to experience cramping, vomiting, gastric distress, diarrhea, and other problems. When it comes to fueling, instead of thinking "What is the maximum amount of calories, fluids, and minerals I can intake without getting sick?" switch to a "What is the minimum amount I can put into my body that will sufficiently fulfill energy requirements?" approach. I guarantee that you will see noticeable improvements in your workouts and races by adopting the "less is better" concept of fueling, adjusting as necessary to meet your individual requirements. A good thing to always keep in mind is that it's a lot easier to resolve an "I've slightly under-dosed my fueling" issue (you simply increase your intake) than it is if you've overdosed your fueling (once that fuel's in your body you can't take it out).

It might seem like we're banging the same drum all the time, but when it comes to fueling, we cannot emphasize enough that less is better than more. Rather than attempting to resolve your fueling requirements by replacing hourly loss with hourly intake, we suggest small doses, generally about a third of what is lost. Along with longstanding research regarding this subject, two decades of successful experience with athletes testifies to the reliability of the "less is better" and "fuel in cooperation with your body" concepts of fueling. Yes, there are people who can complete events on high intakes of fluids, calories, and electrolytes, but the overwhelming majority of athletes are impaired or stopped by such fueling protocols. Athletes who do use less see their fueling-related problems end and their performance improve dramatically.

That's why our banner reads, "Replenish, Don't Replace." The real bottom line is what works for you, and we're pretty darn sure once you get away from those 500-700 calorie and liter-an-hour regimens, your body will perform much better, you'll feel better, and you'll get the results you trained for.

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15 Simple Ways To Improve Your Athletic Performance Right Now

Fueling Guidelines That Are Easy To Follow And Incorporate

Proper fueling of the body prior to, during, and after exercise requires personal experimentation to find the ideal fit for you, the individual athlete. There is no "one size fits all" approach; we are all "experiments of one" when it comes to fueling during exercise. You need to determine, through trial and error in your training, what works best for you. However, there are some basic guidelines that will enable you to eliminate much of the guesswork, so you can more rapidly learn how to properly fuel your body during workouts and races, allowing you to enjoy higher quality training sessions and better race results.

Some of these recommendations may seem pretty foreign to you, especially in regards to fluid, calorie, and electrolyte replenishment during exercise, where some "experts" tell you that you need to eat and drink at or near depletion rates. Before you subscribe to and follow those suggestions, consider the words of Bill Misner, Ph.D.:

> The human body has so many survival safeguards by which it regulates living one more minute, that when we try too hard to fulfill all its needs we interfere, doing more harm than good. If I replace all the fuels I lose at the rate of 700-900 calories per hour, I bloat, vomit, present diarrhea, and finish the event walking or

at an aid station. If I replace all the fluids lost all at once, I end up in the emergency tent with an IV for dilutional hyponatremia. If I replace all the sodium my body loses at the rate of 2 g/hour, I end up with swollen hands, eyes, ankles, feet, and noticeably labored exercise, or hypernatremia-induced bonking.

At an easy aerobic pace, the rate of metabolism increases from a sedentary state to a range of 1200-2000%. As a result, the body goes into "survival mode" where blood volume is routed to working muscles, fluids are used for evaporative cooling mechanisms, and oxygen is routed to the brain, heart, and other internal organisms. Interestingly, it is NOT focused on calorie, fluid, and electrolyte replacement, as some of the "experts" advise.

Pretty bold words (and warnings), indeed. The truth is that you don't need to suffer with the undesirable maladies Dr. Misner describes; they're not a mandatory part of being an athlete. If you follow our suggestions, we believe you will not only avoid performance-ruining and potentially health-threatening consequences, you will also have much more enjoyable experiences and achieve better performances in your workouts and races.

These suggestions have their roots in science and have been proven time and time again (and again and again) over the course of several years. You have nothing to lose, and a whole lot to gain, by testing them in your training. I'm betting that the more of the following recommendations you adopt and practice in your training and racing, the fewer problems you'll run into fueling-wise and the better your performance will be.

1. Keep fluid intake during exercise between 600-825/ml (approximately 20-28 ounces) per hour.

There's probably more misinformation on the subject of hydration than any other aspect of fueling, which is really bad because overhydration also presents the most serious physiological consequences of any fueling issue. Acute overhydration can cause hyponatremic (low sodium) induced coma and death.

Most athletes, under most conditions, will satisfy hydration needs with a fluid intake in the 600-825 ml/hr range. Cool weather exercise might require only a little over half of that. Larger athletes and/or athletes exercising under very hot and humid conditions are the ones that can consider fluid intakes at the high end of that range (825 ml/hour), perhaps even upwards of up to 900 ml/hour. Sure, you can sweat more than that, but you cannot physiologically replace it ounce-for-ounce. Regular fluid intake close to or over a liter hourly really increases the potential for serious performance and health problems, so keep that in mind before you indiscriminately gulp down excessive amounts of fluid. If you override your internal mechanisms, you'll find out the hard way how your body deals with excess water intake during intense exercise. Unless you enjoy nausea, bloating, and DNFs, forget advice like "drink to replace" or "drink even when you're not thirsty"-it's just plain wrong.

2. Restrict caloric intake to 300 cal/hr during exercise.

If you want to watch your race go down the drain fast, follow the "calories out, calories in" protocol that some "experts" recommend. **Fact: your body can't process caloric intake anywhere near your expenditure rate.** Athletes who attempt to replace all the fuels they lose-which can be upwards of 700-900 calories per hour-will most likely end up with bloating, nausea, vomiting, and/or diarrhea. Sound like a good strategy to you? We didn't think so.

If you want to achieve your best performance, replenish calories in "body cooperative" amounts, allowing your fat stores to make up the difference, which they will easily do. For most athletes, 240-300 cal/hr will do the job. For lighter athletes, 180-200 cal/hr may be just the ticket, while larger athletes can consider hourly intakes of slightly over 300 cal/hr.

Far too many athletes think they need to match calories out with equal amounts of calories in. They're usually the ones on the side of the road or off the back, waiting for their stomach to stop rebelling. If you follow a more sensible caloric intake, you'll be blowing by them, not joining them.

3. Avoid simple sugars in your fuels; use complex carbohydrates only.

You've heard the phrase "garbage in, garbage out," right? Guess what-simple sugars (glucose, sucrose, fructose, and dextrose) are garbage. They're inefficient fuels for exercise, and they're health hazards when consumed regularly in typical dietary quantities. They have no place in your body.

This leads to the question, "Why do companies include these types of sugars in their products?" Most likely because simple sugars are cheap, they sweeten the product, and they allow the label to read, "Packed with XX carbs per serving." But just look at the side panel to find out what you're really getting.

Simple sugars give you energy peaks and crashes, and they also have a severe limitation on absorption. They need to be mixed in weak concentrations for efficient digestion, which means you can only intake about 100 cal/hr. You can consume more, but you can't absorb more. You'll only get sick trying. Complex carbohydrates, however, absorb at about three times the rate as simple sugars. That covers the 300 cal/hr we just mentioned. Plus you get smooth, steady, reliable energy-no peaks and valleys. Yes, complex carbohydrates do contain, as part of their naturally occurring structure, a small percentage of 1- or 2-chain sugars. There's a big difference, however, regarding how your body responds to these sugars when they are "part of the whole" rather than when they're isolated and added to a product as a separate ingredient… big difference.

Look, we're not going into a long physiology lesson now; we just want to save your body, your health, and your performance. If you take the "garbage in, garbage out" concept with any seriousness you'll avoid the glucose/sucrose/fructose/dextrose products and stick with complex carbohydrate fuels.

4. Exercise over two hours requires protein, too.

Carbs alone won't satisfy all of your energy requirements once you exceed two hours or so. Protein will have to satisfy roughly 10% of your energy requirements. You have two choices: (1) Use a fuel such as Perpetuem that contains both complex carbohydrates and soy protein, or (2) Allow your body to literally feed upon itself (that is, digest your own muscle tissue) to make fuel. Did you pick #1? Good call!

5. Use soy, not whey, during exercise.

Whey protein is a superb protein when it's used at the right time: *after* exercise. **Do not** use it before or during because the added glutamine quickly degrades to produce ammonia. Ammonia build-up is a primary culprit in muscle fatigue, and you're already producing ammonia when you exercise. Don't make it worse.

Now, there is some confusion regarding glutamine and ammonia that we'll clear up. Yes, glutamine does eventually scavenge ammonia. The key word, however, is "eventually." When glutamine metabolizes it increases ammonia initially, but then scavenges more than originally induced systemically, *taking approximately three hours or so for it to accomplish this.* Again, since you're already producing ammonia during endurance exercise and since ammonia is a primary culprit in fatigue, it seems logical that you'd not want to increase ammonia levels. However, that's exactly what you'll do when you consume glutamine supplements or glutamine-enhanced whey protein during exercise.

Soy or rice gives you the protein you need with minimal extra ammonia production. After exercise, when ammonia production is not an issue, glutamine-enhanced whey protein is great for immune system boosting, muscle tissue rebuilding, and enhanced glycogen synthesis.

6. Use liquid fuels as your main energy source, even during prolonged training and races.

There's nothing wrong with consuming a *little* solid food on occasion during prolonged exercise as a pleasant diversion from the monotony of liquid fuel consumption, but you must:

• Make wise choices. Choose foods that have little or no refined sugar and saturated fats. Don't think, "I'm a calorie burning machine so I can eat anything that I want." What you put in your body greatly determines what you get out of it. Remember: garbage in, garbage out!

• Make solid food consumption the exception, not the rule.

Solid food is harder to digest than liquid, and it requires more time, water, and electrolytes. Relying too heavily on solid foods can leave you feeling lethargic, bloated, and nauseated. Liquid fuels digest and absorb readily, so you avoid those unwanted maladies. Most of all, avoid all junk foods, which contain lots of saturated fats and refined sugars, at all times. Believe me, when the latter stages of the race are upon you, you'll be thanking yourself that you took a pass on that sugar & fat laden pastry earlier in the race.

7. Remember to replenish electrolytes during exercise.

Electrolyte replenishment is as important a component of proper fueling as the fluids you drink and the calories you consume because they (electrolytes) are crucial for maintaining the optimal performance of many of the body's functions such as proper muscular contraction. You can get your energy fuels ("gasoline") dialed in right, but if you neglect the electrolytes ("oil"), the dash light comes on-except your body doesn't have a dash light. Instead, you get cramps, spasms, muscle revolt, irregular and rapid heartbeat, and major bonk. Don't wait for the light to come on; those are the *final* symptoms of increasing impairment. If you don't respond well *before* your body's oil light comes on, you can pretty much kiss optimal performance, and probably the whole race, goodbye.

8. Don't rely on salt tablets to fulfill electrolyte requirements.

• "Electrolyte replenishment" does not mean "sodium or salt replenishment." Sodium chloride (a.k.a. "salt") is indeed an important component of electrolyte replenishment but it does not fulfill the entire requirements. Calcium, magnesium, and potassium should be replenished as well as all these minerals play key roles in the maintenance of many important body functions.

• Most of us obtain more than enough salt from our daily diet and most athletes have a reservoir of upwards of 8,000 - 10,000 mg stored in body tissues. In other words, when you start your race you'll most likely be doing so with a huge reserve of sodium chloride "on board."

• Keep in mind that "too much" can have as many performance inhibiting-to-ruining consequences as "not enough." Over the years we have observed that far too many athletes "over salt" their bodies during exercise, with a variety of maladies such as bloating, water retention (edema-like symptoms), and stomach distress being the usual and undesirable outcome.

When it comes to sodium/salt replenishment the key is to provide an appropriate dose to support the maintenance of normal body functions without overwhelming the body with too much, which will override and neutralize those mechanisms.

Because full-spectrum electrolytic mineral supplements are not available in Australia, you'll have to rely more heavily on your fuels to help satisfy your electrolyte needs. However, don't make the mistake of taking copious amounts of salt tablets in the hopes that they'll satisfy your body's electrolyte requirements. Remember, you want to provide your body with adequate amounts of sodium while taking care to not overload your body with too much. Supplementing with salt alone or consuming too much salt overrides the complex and precise mechanisms that regulate sodium re-circulation. There are just as many performance inhibiting-to-ruining consequences from taking too much salt as there are from not taking enough so keep that in mind before you indiscriminately pop salt tablets.

Many sports drinks contain only salt and potassium whereas HEED and Perpetuem provide all the minerals your body needs - sodium, chloride, calcium, magnesium, and potassium. Are the amounts in each serving capable of fulfilling all athletes' needs under all conditions all the time? Probably not. However, during short duration workouts/races HEED should cover most-to-all of your electrolyte needs. During long distance events, a combination of both HEED and Perpetuem should sufficiently satisfy your electrolyte requirements.

These two products supply *all* of the electrolytic minerals you need - not just salt and potassium - so you've got a much better opportunity of fulfilling your electrolyte requirements with more precision from these two fuels than you can from the typical sports drink. The bottom line is that no sports drink can meet every athlete's electrolyte needs under all conditions all the time but with HEED and Perpetuem you're giving yourself a much better option than you would from the typical sports drink.

9. Don't use any new supplement or fuel, or supplement/fueling protocol, in a race with-

out having first tested it in training.

This is a cardinal rule for all athletes, yet you'd be amazed how many break it. Unless you're absolutely desperate and willing to accept the consequences, do not try anything new in competition, be it equipment, fuel, or tactics. These all must be tested and refined in training.

Because all Hammer fuels are specific and formulated to easily combine with one another, you have all the flexibility you need to ensure that you can tailor a fueling program for any length of race, regardless of conditions. You'll never have to guess or try something off the aid station table in hopes of trying to keep going another hour.

10. Be flexible with your fuel consumption during a race, keeping in mind that what may have worked in training may not be appropriate under race conditions.

Caloric intakes that worked during training may not be appropriate during a race; you may need to consume slightly less in a race than you did during training. Why? Increased anxiety, increased pace, and increased potential for dehydration all contribute to the possibility of a less-than-optimally functioning digestive system. In addition, at the increased pace during a race, more blood is diverted from digestion and directed toward maintaining muscle performance.

When you get to the race it's great to have a caloric "game plan" in place, but don't be a slave to it. You may need to alter that game plan (which may mean a slightly lower hourly intake of calories) to accommodate the possibility of a less-than-optimal digestive system.

11. Replenish your body with carbohydrates and protein as soon as possible after each exercise session.

Here's a statement to remember: "When you're done training, you're not done training… at least not until you've put some fuel back into the body." Equally important as your workout (muscle exhaustion and nutrient depletion) is what you do immediately following your workout (muscle repair and nutrient replenishment). If you neglect to refill the tank, you'll never get the full value out of all the work you just put in… and what a waste that would be.

Increased fitness simply won't happen, at least not efficiently or effectively, if you ignore your body's cries for fuel replenishment. Give your body what it needs immediately after exercise, when it's most receptive to replenishment, and it will respond wonderfully-recovering faster, efficiently adapting to physical stress, and "learning" how to store more and more readily available fuel in the muscles.

An ideal and easy-to-use post-workout fuel is Recoverite, with its 3:1 ratio of complex carbohydrates and protein. Mix a couple of scoops with water, drink, you're done… simple. You've just put the best "finishing touches" on your workout that you possibly could, and you've given your body a great head start on tomorrow's workout.

12. Don't over-consume food the night before the race in the hopes of "carbo loading."

It would be nice if you could maximize muscle glycogen stores the night before the race, but human physiology doesn't work that way. Increasing and maximizing muscle glycogen stores takes many *weeks* of consistent training and post-workout fuel replenishment. Excess consumed carbohydrates are only going to be eliminated or stored as body fats (dead weight), so don't go overboard during those pre-race pasta feeds. Eat until you're satisfied, but not more.

13. Finish a pre-race meal three hours prior to the start of the race.

Let's assume you've been really good - you've been training hard (yet wisely) and remembering to replenish your body with adequate amounts of high quality calories as soon as possible after each and every one of your workouts. Great! You've now built up a nice 60-90 minute reservoir of premium muscle glycogen, the first fuel your body will use when the race begins. Don't blow it now by eating something an hour or two prior to the start of the race!

Do you know what happens when you eat within three hours of exercise? Your muscle glycogen stores get burned much more rapidly . . . definitely not performance-enhancing! If you're going to have a pre-race meal, you need to finish it three hours prior to the start of the race. That's the best way to top off liver glycogen stores (the goal of the pre-race meal) without screwing up how your body burns its muscle glycogen. Not possible to get up and eat three hours before the race? Read on.

14. Don't sacrifice sleep to eat a pre-race meal.

OK, you're convinced that it's a good idea to eat at least three hours prior to the start of your race. "But wait," you say. "My race starts at 7 a.m. Are you telling me I have to get up at 3 a.m. or so just to eat?" Well, you *could* get up to eat if you're so inclined, but you don't *have* to. The fuel you've got stored in the muscles is going to be there, full strength, even after a night-long fast (really). In the morning your brain may be saying, "I'm hungry," but your muscles are saying, "Hey, we're good to go."

Bottom line: do not sacrifice sleep just to eat. If you've got an early morning race start, the best strategy is:

• Eat a high quality meal the night before (topping off liver glycogen stores)
• Get an adequate amount of sleep
• Have 100-200 calories of easily digested fuel (Hammer Gel is ideal) 5-10 minutes prior to the start of the race

That's right, 5-10 minutes prior, not one or two hours prior. The key, in terms of muscle glycogen depletion rates, is in the timing. If you must eat before the start of your race, you need to complete consumption three hours prior. If that's not logistically feasible, have a little something 5-10 minutes prior. Do that and you won't expend your hard-earned glycogen too rapidly.

15. Consume appropriate amounts of high quality food for your pre-race meal.

The goal of the pre-race meal is to top off your liver glycogen, which has been depleted during your sleep. Believe it or not, to accomplish this you don't need to eat an 800-1000 calorie (or more) meal, as some would have you believe. A pre-race meal of 200-400 calories-comprised of complex carbohydrates, perhaps a small amount of soy or rice protein, and little or no fiber or fat, and consumed three hours prior to the start of the race-is quite sufficient. You can't add anything to muscle glycogen stores at this time (you'll just be topping off liver glycogen stores), so stuffing yourself is counterproductive, especially if you've got an early morning race start.

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Recovery - A Crucial Component For Athletic Success

Athletes tend to focus on training and neglect recovery, specifically the critical step of refueling as soon as possible after each workout. We tend to think that a hard workout deserves a nice reward. Do you usually first go for a shower or relaxation after a hard workout? Is beer and chips your favored post-workout snack? I want to remind you that a hard workout has left your body in a state of utter depletion and physiological vulnerability. However, it's also in a state of prime receptivity, ready to absorb nutrients. Taking that few extra minutes to properly refuel is one of the most important things that you can do to improve your race day results. In fact, properly refueling your body immediately after your training session is as important as anything you did in the actual workout. When you give your body what it needs as soon as possible after exercise, it will respond wonderfully in the following ways:

- Your body will be able to store more and more of a premium, ready-to-use fuel known as muscle glycogen.
- You will strengthen, not weaken, your immune system.
- You will "kick start" the rebuilding of muscle tissue.

You can really give yourself a major advantage come race day if you'll take the time to put some quality fuel into your body as soon as possible after all your workouts.

If you're at all serious about performing better in your racing ***and*** staying healthier, then take heed to this saying: **"When you've finished training, you're still not finished with training!"** Here's what I mean: You must attend as much to recovery as you do to active exercise if you expect to reap the benefits of hard training. In other words, how well you recover today will be a huge factor in how well you perform tomorrow. Exercise, done properly, creates enough stress to your muscles and cardiovascular system to instigate a rebuilding and strengthening program, but without causing big-time damage. Your body responds by adapting to the stress you placed upon it. Too much exercise at once leads to over-training syndrome. If you train within limits, but fail to supply your body with adequate fuel and nutrients, you get pretty much the same thing: over-use symptoms such as weakening, increased susceptibility to infections, and fatigue.

Recovery includes many factors, including rest, stretching, muscle stimulation, and sleep, but we will limit our present discussion to the nutritional aspects. This article will cover the four essential nutritional areas of recovery: **rehydration**, the **two macronutrients** (carbohydrates and protein), and **micronutrients** (primarily antioxidants).

Rehydration

Technically, of course, water has no nutrient value, but it's essential for performance and recovery, and well worth a couple of paragraphs here. The normal course of recovery nutrition intake will meet most hydration needs, but it is possible for an athlete to suffer from chronic dehydration. In the article on hydration ("Hydration—What You Need To Know," found in *The Endurance Athlete's Guide to Success*) we caution against excess fluid intake, a more common problem than dehydration, especially among the mass of recreational and fitness athletes. Top-level competitors, however, tend to under-hydrate during races.

As a rule of thumb, you want to finish a workout with not more than about 2% body weight loss, and certainly no weight gain. Weight loss in excess of 2% signals performance decline. For example, if you go out at 160 lbs (approx 72.5 kg) and return several hours later at 156 lbs (just under 71 kg), you're probably a bit dehydrated, but that would not be an unusual deficit after a hard workout or race. (Obviously, a steady, reliable scale is important here.) At a pint a pound (roughly 475 ml per ? kilogram), four pounds (nearly two kilograms) lost means you need to drink at least a good half-gallon (64 ounces, or just under two liters) of fluids in the next few hours. That's fairly easy, and much of the fluid intake will come in the normal course of nutritional replenishment anyway.

Carbohydrate replenishment—The sooner the better!

Now let's consider carbohydrate replenishment, the most obvious nutritional issue caused by endurance exercise. When you know the mechanism of carbohydrate replenishment, you can very effectively dial in your energy recovery program, so let's briefly review your energy use and restoration cycle. When you begin a workout or race, the primary fuel your body uses for the first 60-90 minutes or so is known as muscle glycogen, a glucose polymer that contains tens of thousands of glucose units arranged in branched chains. As your stores of muscle glycogen become depleted, your body switches over to burning fat reserves along with carbohydrates and protein consumed during exercise. You've only got so much of this premium fuel, muscle glycogen, but its importance can't be overstated. In fact, several studies have shown that the pre-exercise muscle glycogen level is the most important energy determinant for exercise performance. Needless to say, to have a good race or workout, you need to start with a full load of muscle-stored glycogen; athletes who have more of this readily available fuel in their bodies have a definite advantage. The good news is that you can substantially increase your glycogen storage capacity through the process of training and replenishing.

Here's how your body does it: Along with insulin, which regulates blood sugar levels of ingested carbohydrates, an enzyme known as glycogen synthase converts carbohydrates from food into glycogen and stores it in muscle cells. This also drives the muscle repair and rebuilding process. However, to maximize the recovery process, you need to take advantage of glycogen synthase when it's most active. Carbohydrate replenishment as soon as possible after exercise, when the body is most receptive to carbohydrate uptake, maximizes both glycogen synthesis and storage. To paraphrase the late Ed Burke, a well-known nutritional scientist, "The sooner you do it, the better." Glycogen synthesis from carbohydrate intake takes place most rapidly the first hour after exercise, remains fairly active perhaps another hour, and then occurs at diminished levels for up to 4-6 hours longer. Researchers at the University of Texas at Austin (United States) demonstrated that glycogen synthesis was highest when subjects were given carbohydrates immediately after exercise. Depletion followed immediately by carbohydrate intake yields the maximum glycogen re-supply.

Complex carbohydrates versus simple sugars

The one time where your body isn't going to put up much of a fuss regarding complex carbohydrates versus simple sugars is right after a hard, glycogen-depleting workout. At this time your body is in such dire need of replenishment that it'll accept just about

anything. That said, complex carbohydrates still offer a distinct advantage over simple sugars, which is why we strongly recommend using them. Here's why: Complex carbohydrates (such as the maltodextrin we use in Recoverite) and simple sugars (except fructose) have a high glycemic index (GI). This allows them to raise blood sugar levels and spike insulin rapidly, both desirable functions post-exercise. However, complex carbohydrates allow for a greater volume of calories to be absorbed compared to simple sugars. In other words, when you consume complex carbohydrates instead of simple sugars after exercise, your body is able to absorb more calories for conversion to glycogen without the increased potential for stomach distress that commonly occurs with simple sugar fuels.

Additionally, most of us already over-consume simple sugars from our daily diets. For example, numerous studies clearly show that sugar consumption in America (and most likely in many other countries as well) is outrageously high. A report from the **Berkeley Wellness Letter** stated that each American consumes about 133 pounds (60+ kg) of sugar annually… that's over 1/3 pound sugar every day, 365 days a year! Excess sugar consumption is implicated in a number of health problems. If simple sugars don't offer any specific post-workout benefits, then why use them?

Bottom line: Use only high glycemic complex carbohydrates (maltodextrins) to optimally replenish glycogen stores. Keep in mind that:

- A less-fit athlete, or one who has not been refueling properly after exercise, has very limited muscle glycogen available, perhaps as little as 10-15 minutes worth.

- A fit athlete who has been consistently refueling his or her body with carbohydrates immediately after exercise can build up a glycogen supply that will last for up to 90 minutes of intense exercise. For instance, a well-trained 160 lb (72.5 kg) marathoner packing some 2000 calories worth of premium fuel can cover 18 miles in 90 minutes at a 5 min/mile pace. He'll need to consume some carbs to finish the race, but he's in good shape fuel-wise.

Which would you rather have when the gun goes off, 15 minutes of on-board fuel or 90 minutes?

It should now be clear that by taking in ample amounts of carbohydrates immediately after training and continuing for the next few hours, you can get a head start on refueling your muscles after workouts. Additionally, consumption of carbohydrates will also tip the scales in the direction of protein synthesis instead of protein catabolism (breakdown). In other words, ample carbohydrates are essential in rebuilding muscle cells as well as restoring muscle glycogen. Studies suggest that the carbohydrate inflow gives the muscle cells the necessary fuel to begin the rebuilding process. Using the energy derived from carbohydrates, the muscles absorb amino acids from the bloodstream, helping initiate protein synthesis.

Carbohydrates also boost the production and release of insulin from the pancreas. Insulin is an anabolic (tissue-building) hormone that has a profound positive impact on protein synthesis in muscles, and it also tends to suppress protein breakdown. A University of Texas (United States) study found plasma insulin values three to eight times higher post-workout for subjects ingesting carbohydrates versus placebo.

Bottom line: For replenishing glycogen stores and aiding in the rebuilding of muscle tissue, quick replenishment of carbohydrates is a must. As soon as possible after you finish your workout, ideally within the first 30 minutes, consume approximately 30-60 grams of high quality complex carbohydrates.

Protein—Essential component for recovery

Carbohydrate intake promotes many aspects of post-exercise recovery, but it can't do the job alone; you need protein as well. Protein in your post-workout fuel provides these benefits:

- **Raw materials to rebuild stressed muscles** - Whey protein is the premier protein source of the three branched chain amino acids (BCAAs - leucine, isoleucine, valine) used for muscle tissue repair.
- **Enhanced glycogen storage** - Numerous studies have shown that the consumption of carbohydrates plus protein, versus carbohydrates alone, is a superior way to maximize post-exercise muscle glycogen synthesis.
- **Immune system maintenance** - We strongly recommend whey protein, with its high levels of amino acids that spur glutathione production (discussed later).

Whey is the superior protein source for recovery

Of all the protein sources available, whey protein is considered the ideal protein for recovery, primarily due to its high Biological Value (BV) rating. The BV is an accurate indicator of biological activity of protein, a scale used to determine the percentage of a given nutrient the body utilizes. In other words, BV refers to how well and how quickly your body can actually use the protein you consume.
Of all protein sources, whey has the highest BV, with whey protein isolate (the purest form of whey protein) having an outstanding rating of 154, and whey protein concentrate having a 104 rating. Egg protein also has an outstanding BV, with whole eggs rating 100 and egg whites (albumin) rated at 88. With a 49 rating, soy protein ranks far below whey protein, making it a less desirable choice for recovery. (When the BV system was introduced, eggs had the highest known BV and thus were given a value of 100. Whey proteins came to researchers' attention later, and they rang up even higher scores. The 154 BV of whey protein isolate and the 104 BV of whey concentrate are in comparison with the original BV benchmark, whole eggs.)

Other standards that evaluate protein quality/effect also show whey to be a superb protein source. One of these methods, the Protein Efficiency Ratio (PER), while it admittedly has limited applications for humans (PER measures the weight gain of experimental growing rats when being fed the test protein), still shows that whey protein ranks the highest, with a rating of 3.6 (soy protein has a rating of 2.1).

Another protein measurement is the Protein Digestibility Corrected Amino Acid Score (PDCAAS). Nutritionists who disqualify the PER method for classifying protein quality (because it only references the amino acid requirements for lab rats) often will use the PDCAAS method for evaluating human protein requirements. According to this method, which utilizes an amino acid requirement profile derived from human subjects, an ideal protein is one that meets all of the essential amino acid requirements of humans. An ideal protein receives a rating of 1.0. Three protein sources—whey, soy, and egg—all have a 1.0 PDCAAS ranking.

One very important point about whey protein: for a supplement, make sure you use whey protein *isolate*, not whey protein *concentrate*. Whey protein isolate is virtually lactose and fat free; many lactose-intolerant people can still use whey protein isolate because it contains only a minuscule amount of lactose. Also, whey isolate checks in at a sturdy 90-97+% protein, whereas whey concentrate contains only 70-80% protein. Simply put, whey protein isolate is a purer protein, and the best protein you can put into your body after a hard workout.

The whey protein used in Recoverite is a pure un-denatured whey protein isolate of the highest quality. It is 97.7% pure, and virtually fat-free (0.5 g fat/100g), and carbohydrate-free (0.5 g lactose/100g). The whey protein isolate in Recoverite delivers rich immune-enhancing beta-lactoalbumins and alpha-lactalbumins. Recoverite's whey protein isolate component has a unique profile of highly bioavailable protein with immune factors, potent branched chain amino acids (BCAAs), lactoferrin, and immunoglobulins. Independent laboratories tests show the PDCAAS (Protein Digestibility Corrected Amino Acid Score) for the whey protein isolate in Recoverite is a whopping 1.14, a score that exceeds all those reported for egg, milk, caseinates, and soy protein.

Glutathione: The key to optimal immune system support & recovery

Glutathione is a tripeptide consisting of the amino acids glutamic acid, cysteine, and glycine. It is one of the three endogenous (naturally occurring in the body) antioxidants, the other two being catalase and superoxide dismutase. Many researchers rate glutathione as the number one antioxidant. Ward Dean, MD, a leading nutritional scientist, in his brilliant article *Glutathione: Life-Extending "Master Antioxidant"* (www.vrp.com/art/1181.asp?c=1153774033109&k=/vrpsearch.asp&m=/includes/vrp.css&p=no&s=0), addresses the importance of glutathione, stating that "Glutathione is present in nearly all living cells, and without it they can't survive… glutathione has major effects on health at the molecular, cellular and organ levels."

One of the most important steps we can do to improve our recovery is to enhance/optimize body levels of this important antioxidant, and one of the best ways to do that is by consuming whey protein. Whey protein contains excellent levels of all three of the amino acids that comprise glutathione, as well as high levels of the sulfur-containing amino acid methionine. The two sulfur-containing amino acids (cysteine being the other) are particularly important for proper immune system function and the body's production of glutathione. In addition, the amino acid glutamine has also been shown to help raise glutathione levels (both Hammer Nutrition whey protein products, Hammer Whey and Recoverite, contain high amounts of glutamine).

Bottom line: Adequate glutathione in the body will enhance your recovery and support optimal health.

Whey protein (Recoverite) vs. Soy protein

A comparison (approximate amounts per gram of protein) for glutathione production

AMINO ACID	Whey Protein Isolate	Soy Protein
Cysteine	33 mg	9 mg
Methionine	17 mg	9 mg
Glutamic Acid	103 mg	138 mg
Glutamine	333 mg	10.5 mg

Branched Chain Amino Acids (BCAAs)—Essential for muscle repair

Of the nearly two-dozen different amino acids required by humans, nine are classified as essential because they cannot be synthesized by the body and must be derived from external food sources. Among these nine essential amino acids are the branched chain amino acids leucine, isoleucine, and valine. The term "branched chain" refers to the molecular structure of these particular amino acids. Up to 75% of the body's muscle tissue is composed of these three amino acids, and they are directly involved in the tissue repair process. BCAAs are present in all protein-containing foods, with whey protein being the best source.

Whey protein (Recoverite) vs. Soy protein

A comparison (approximate amounts per gram of protein) of BCAAs (branched chain amino acids)

AMINO ACID	Whey Protein Isolate	Soy Protein
Leucine	100 mg	59 mg
Isoleucine	51 mg	36 mg
Valine	36 mg	36 mg

Bottom line: Soy protein is certainly an excellent protein source for a variety of health benefits. However, when it comes to enhancing recovery between workouts—maximizing glycogen synthesis, supporting immune system function, and rebuilding lean muscle tissue—you simply won't find a better protein source than whey protein isolate. After your workouts, consume 10-30 grams of protein, preferably whey isolate, along with your complex carbohydrates.

Recoverite—The perfect carb/protein product

By now, I have hopefully impressed upon you the importance of immediate post-workout re-fueling. By replenishing your body with quality carbohydrates and protein as soon as possible after each of your workouts you get the very most out of every minute you put into each of your training sessions, helping your body adapt and allowing it to increase its workload potential.

While consuming "real food" as your post-workout fuel is certainly acceptable, oftentimes it's not convenient nor is the body's digestive system always ready or able to accept and digest solid food shortly after a training session. This is why Recoverite is such a useful product as it supplies exactly what your body craves after it's been put through a tough workout while also being extremely convenient and easy to digest.

The precise ratio of complex carbohydrates and whey protein isolate, and added glutamine supports enhanced recovery, and thus enhanced athletic performance, three ways:

1) **Maximal muscle glycogen synthesis** - As discussed earlier, as part of the adaptation process to your training, your body will store more and more of a premium fuel known as muscle glycogen, which is the first fuel your body will use for tomorrow's workout or race. The key to maximizing your body's ability to store as much glycogen as possible is to consume proper amounts of quality calories as soon as your training session is complete, when glycogen synthase activity is at its highest. Recoverite provides your body with the complex carbs it needs with added chromium, which supports muscle glycogen synthesis.

2) **Muscle tissue rebuilding** – After workouts and races your body is in dire need of the raw materials it requires for the reparation and rebuilding of lean muscle tissue. Protein provides the amino acids, those "raw materials" the muscles des perately need, and there is simply no better protein for recovery purposes than whey protein isolate, the only kind you'll find in Recoverite. As discussed earlier, whey protein isolate is the purest source of the most bioavailable form of protein, with the highest amount of branched chain amino acids (BCAAs) of any protein source.

3) **Superior immune system functioning** – Staying healthy is an obvious necessity to maintaining and improving athletic performance. The high amounts of specific amino acids that naturally occur in whey protein, plus the added amounts of the amino acid glutamine included in Recoverite, all contribute to supporting the optimal functioning of the immune system.

In addition, Recoverite also provides a full-spectrum electrolyte profile, which helps replenish depleted essential minerals and aids in preventing post-workout or race cramping, a common malady amongst endurance athletes.

Why a 3:1 carbohydrate to protein ratio?

As mentioned earlier in the article, timely post-workout carbohydrate and protein replenishment helps optimize glycogen synthesis and rebuild muscle tissue. While other products use a 4:1 ratio of carbohydrates to protein, Recoverite supplies those two components in a 3:1 ratio, which we believe is the ideal ratio for enhanced recovery. Dr. Bill Misner explains:

Research supports the concept for utilizing four parts carbohydrate to one part protein during the [brief] window-of-opportunity in order to exogenously impact lean muscle mass growth and glycogen re-storage. Shortly after Ivy and Burke and several others specified results with a 4:1 ratio, a patented product was then marketed. Another research paper using elderly subjects in strength exercise (weights) found conclusively that when these subjects lifted weights three days per week and consumed one part carbohydrate to one part protein, they positively achieved lean muscle mass growth gains. This later study skews the conclusion of the former, calling for the question of what carbohydrate to protein ratio best supports lean muscle mass growth and glycogen re-storage post-depletion workout. In other words, research is inconclusively leaning toward the 4:1 ratio, but has not excluded the 3:1 or 5:1 ratios, due to not having studied them as much as the patented 4:1 ratio. This leaves me with the opinion that as far as conclusive research data goes, the jury is still out waiting for more papers to be published on other ratio values.

An endurance exercise session lasting more than three hours depletes muscle glycogen and likely cannibalizes around 50-60 grams of lean muscle proteins, and probably around 500-600 grams glycogen, which should be replaced. The total dietary replacement ratio then is at least 10:1 carbohydrates: protein. Since the glycogen synthase enzyme released during glycogen depletion has a short half-life effective for 90-120 minutes, but most effectively available at 30 minutes post exercise, it behooves us (according to Colgan, Costill, Noakes, Hawley, Ivy etc) to drive replacement proteins on the insulin-glycogen synthase "train" for effective maximal replacement. If you try to replace all the glycogen in one or two meals spaced an hour apart with all the protein, too much carbohydrate in one meal will produce excess adipose fatty acid storage. Cutting the carbs down to small dose will produce the insulin and provide maximum storage rate for the protein fraction delivery into the muscle cell for the lean muscle mass rebuilding process.
The 3:1 carbohydrate to protein post-exercise protocol is rational for the endurance athlete, especially if lean muscle mass recovery is the objective. Adding one more part carbohydrate raises the carbohydrate component (to 4:1) and may be beneficial for athletes who are free from carbohydrate-induced fat weight. Of the two ratios—3:1 or 4:1—the low-carb Recoverite appears to be favorable for endurance lean muscle gain than the 4:1 higher carb patented formula. Altering the formula in any direction toward more protein or more carbohydrate should be monitored by fat weight gain and lean muscle mass gain accordingly.

Since we saw the research that showed positive lean muscle mass growth in older subjects using 1:1 carbohydrate to protein recovery refueling, our opinion is that the lower carbohydrate version [3:1 ratio] is superior to the higher carbohydrate version.

Bottom line: Recoverite provides unsurpassed nutritional support to ensure that you obtain the maximumvalue from your workouts and complete recovery after each training session and race.

Micronutrient replenishment

To enhance recovery, it's important to replenish basic vitamins and minerals depleted during exercise. Additionally, it's extremely important to provide the body with a variety of antioxidants. You may have noticed that we have not mentioned Recoverite's vitamin profile. That's because it contains none. Yes, vitamins are indeed important in recovery, but most, if not all, recovery products contain only a limited number of vitamins and/or insignificant amounts of whatever vitamins they do provide. To completely replenish vitamins and minerals lost during exercise, use a product that provides adequate amounts of the full spectrum of necessary vitamins and minerals.

Antioxidants—Your body's protection against free radicals

Our bodies need antioxidants to protect us from the damaging effects of free radicals. Free radicals (of which there are several types) are unstable atoms or molecules, usually of oxygen, containing at least one unpaired electron. Left unchecked, free radicals seek out and literally steal electrons from whole atoms or molecules, creating a destructive chain reaction. Excess free radicals, in the words of one nutritional scientist, "are capable of damaging virtually any biomolecule, including proteins, sugars, fatty acids and nucleic acids." Dr. Bill Misner writes:

Oxygen has the capacity to be both friend and foe. When energy fuels are metabolized in the presence of O2, 5% of them create molecules that contain an odd number of electrons. If free radicals are not neutralized by on-site antioxidant body stores immediately, tissue damage occurs to absolutely every cell membrane touched by these imbalanced molecular wrecking machines. Some theorize soreness and stiffness result because free radicals and waste metabolites build up during either prolonged or intense exercise. The more volume oxygen that passes into our physiology

for energy fuel metabolism, the more increased free radical-fatigue symptoms may be experienced.

Those words should sound the alarm bells loud and clear, because as an athlete you consume huge amounts of oxygen and metabolize far greater amounts of calories than a sedentary person does. This means you're generating free radicals on the order of 12-20 times more than non-athletes! During periods of peak training and racing stress, free radical production increases even more. While the benefits of exercise far outweigh the potential negatives caused by free radicals, excess free radical production and accumulation, if not properly resolved, may very well be the endurance athlete's worst foe. The human body can oxidize and decay, like rusting steel, from excess free radical production. Not only can this negate everything you've worked so hard to achieve in your training, but it can also result in severe consequences to your overall health.
There are a number of antioxidant-rich foods including every type of fruit (berry fruits such as blueberries, strawberries, and blackberries are exceptionally high in antioxidants), vegetables (such as carrots, tomatoes, artichokes, broccoli, spinach, peppers, and potatoes… yes, potatoes!) and legumes (black beans, pinto beans, and red kidney beans). Consuming a wide variety of fruits, vegetables, legumes, and nuts on a daily basis will help provide a wide range of antioxidants and other beneficial phytonutrients to the body.

Antioxidants to consider supplementing with include: Beta-carotene*, vitamin C*, vitamin E*, manganese*, selenium*, zinc*, coenzyme Q10, alpha lipoic acid, lycopene, astaxanthin, pine bark extract (pycnogenol) or grape seed extract (both provide an antioxidant substance called OPC), and ginkgo biloba.

* - These are typically found in a multivitamin/mineral supplement

Bottom line: Clearly, the necessity of neutralizing excess free radicals cannot be overstated, which is why we recommend intake of a variety of antioxidants. These are the salient points to keep in mind:

- Antioxidants are a group of micronutrients that are desperately needed post-workout.
- You need a wide spectrum of antioxidants because prolonged exercise produces many different types of free radicals. Each antioxidant targets different free radicals, so don't make the mistake of thinking that any one antioxidant, say vitamin E, will protect you from all the ravages of free radical production.
- Consuming antioxidant-rich foods and taking antioxidant supplements throughout the day—targeting primary intake post-workout—is an ideal way to support enhanced immune system health.

Summary

Improved athletic performance depends on successive, incremental exercise sessions that stimulate muscular and cardiovascular adaptation, followed by a recovery period in which the body rebuilds itself slightly more fit than before. Thus, the real gain of exercise occurs during recovery, but only in the presence of adequate rest and ***optimal nutritional support***. Therefore, how well you recover today will greatly determine your performance tomorrow. A comprehensive recovery program will address all the nutritional categories described above, in addition to rest, stretching, and the other physical modalities. Athletes who attend to the recovery process as much as they do to active training are way ahead of the game and will no doubt enjoy increased performance.

More detailed information about proper fueling and all the Hammer Nutrition products can be found in The Endurance Athlete's Guide To Success. You can download a free copy at: **www.hammernutrition.com.au/fuelinghandbook.pdf**

Steve Born is a technical advisor for Hammer Nutrition with over a decade of involvement in the health food industry. He has worked with hundreds of athletes - ranging from the recreational athlete to world-class professional athlete - regarding their supplement/fueling program. Steve is a three-time RAAM finisher, the 1994 Furnace Creek 508 Champion, 1999 runner-up, the only cyclist in history to complete a Double Furnace Creek 508, and is the holder of two Ultra Marathon Cycling records. In February 2004 Steve was inducted into the Ultra Marathon Cycling Hall of Fame.