For two decades, PacificHealth Laboratories has had a singular mission – develop innovative nutrition products based on cutting-edge research. To achieve this goal, PacificHealth collaborates with many of the world’s top nutritionists, biochemists and sports scientists. We are proud that this collaboration with the scientific community has resulted in many discoveries that have reshaped our understanding of sports nutrition.

We also feel that part of our mission is to provide serious athletes the latest information on how to improve exercise performance. The first Performance Nutrition Handbook was incredibly well received by the endurance community – over 300,000 copies were printed and distributed and hundreds of thousands more were downloaded from various websites.

I am proud to introduce the second edition of the Performance Nutrition Handbook. This edition includes the latest information and science on muscle recovery, fatigue, functional eating and rehydration to name a few of the topics. This is part of PacificHealth Laboratories continuing commitment to help triathletes, endurance athletes, coaches and trainers safely raise the level of athletic performance.

Dr. Robert Portman

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OPTIMIZING MUSCLE RECOVERY

Dr. Robert Portman answers frequent questions about muscle recovery.

Q: If I miss the 45-minute recovery window, does it make sense to consume a recovery beverage?
A: The recovery window does not slam shut after 45 minutes. Instead, there is a rapid fall off in benefit. After about two hours, you get almost no benefit. Consuming a recovery beverage within 45 minutes maximizes glycogen replenishment and the repair and rebuilding of damaged muscle protein.

Q: Do I always need to drink a recovery beverage after exercise?
A: The rule for when to consume a recovery beverage is based on the intensity and duration of your exercise. For example, short high-intensity exercise and long low-intensity exercise are both situations where a recovery beverage is very beneficial.

Q: Since there is muscle protein breakdown after exercise, wouldn't it be better to drink a protein supplement?
A: A popular misconception is carbohydrate is for endurance sports and protein for strength training. The fact of the matter is both forms of exercise require protein. Although it seems counterintuitive, combining carbohydrate and protein actually works better than a protein supplement in stimulating muscle protein synthesis. The reason is protein synthesis is turned on via two pathways. One involves amino acids and the second involves insulin. When you consume protein alone you only switch one pathway. When you consume a carb-protein combination, especially one that uses a 4:1 ratio, you stimulate two protein building pathways. Research has shown that a carb-protein beverage is 38% more effective than a protein beverage in stimulating muscle protein synthesis post exercise.

Q: Is there any benefit in consuming caffeine after exercise?
A: Endurance athletes should incorporate caffeine into their nutritional training regimen. Caffeine, in combination with carbohydrate and protein, has been shown to significantly extend endurance and reduce brain fatigue. One of the actions of caffeine is to increase the absorption of carbohydrate in the GI tract. This action enables carbohydrate to be more rapidly transported to working muscles where it can be rapidly converted into energy during exercise. The result—extended endurance. This action of caffeine is also valuable during the recovery process. The faster muscle glycogen stores are replenished, the better the recovery and the greater the benefit. One additional benefit of caffeine concerns muscle soreness. Researchers showed cyclists who consumed caffeine after exercise experienced less muscle soreness.

IS CHOCOLATE MILK THE BEST RECOVERY DRINK?

A number of studies have shown that chocolate milk is better than a conventional carbohydrate sports drink in facilitating muscle recovery. However, these studies also show that chocolate milk is a long way from matching the recovery benefits of Endurox R4. Here’s why. Chocolate milk contains casein, which is more slowly absorbed than whey (the protein in Endurox R4) and also contains a lower level of leucine, an amino acid vital for turning on protein synthesis. Chocolate milk also contains lactose, which is slowly absorbed and a poor stimulator of insulin, the mediator responsible for a quality recovery. Unlike Endurox R4, chocolate milk has no reported effect on muscle damage. Because of these ingredient differences, it is not surprising that the endurance benefits of chocolate milk are considerably less than Endurox R4. Researchers reported a 7% improvement in endurance performance in a subsequent exercise bout with chocolate milk compared to a carbohydrate-only beverage. Although the 7% improvement with chocolate milk is impressive, Endurox R4 achieved a 55% increase or almost 8-fold better. The bottom line—although the chocolate milk story makes for great media, it does not make for great recoveries.
SLEEP YOUR WAY TO BETTER RACE TIMES

The average triathlete has a time management problem. Twenty-four hours just isn’t enough time to juggle the competing interests of family, job and training. The problem is exacerbated because we live in a 24/7 world. Since our day cannot be extended beyond 24 hours, adjustments have to be made. For most triathletes, the easiest adjustment is to cut down on their sleep time.

Sleep time has been steadily decreasing since the 1960’s when the average adult slept 8.5 hours per night. Now it is less than seven hours. Most people are aware that sleep deprivation causes a number of behavioral issues, lack of concentration, irritability and increased anxiety. If you are a serious age group athlete you can deal with these issues and hope that your family and coworkers will be understanding.

Master Clock
However, most triathletes may not realize that sleep deprivation can significantly affect the metabolic circuits that determine fitness. When our daily regimen interferes with our genetic programming, it has major implications on training and performance. All of us are familiar with circadian rhythm, especially if we have traveled through multiple time zones in 24 hours. However, our circadian rhythm controls more than just our sleep and eating patterns. It is basically the master time clock that coordinates the release of hormones and other metabolic activators and controls our metabolic pathways.

The master clock is programmed so that we are physically active during daylight hours and sleep at night. This adaptation was crucial because our senses of smell, hearing and sight never developed to the level necessary for us to successfully hunt and be active at night. Although our modern lifestyle challenges our nocturnal limitations, our master clock represents a potent force in determining our daily natural metabolic rhythms.

Our internal clock is the master controller of our fitness level and ultimately our overall health and longevity, so when we interfere with its normal rhythm, it has dramatic effects on the function of our fitness circuits. Research indicates that sleep deprivation impacts endurance performance in three ways: 1) by decreasing the efficiency with which muscle cells convert fuel into energy, 2) by interfering with normal appetite circuits, and 3) by negatively impacting muscle recovery.

Sleep and Energy
Although we live in a 24/7 world, our bodies are still hardwired to operate in the day time. As we move more of our activities into the nighttime, studies show insulin levels increase. In the presence of higher insulin levels, there is a decrease in the efficiency with which carbohydrate is converted into energy and an increase in the conversion of carbohydrate to fat. Any decrease in metabolic efficiency translates into a decrease in endurance performance.

Sleep and Appetite
The second consequence is that sleep deprivation interferes with normal appetite function. Maintaining the caloric balance between exercise activity and food consumption is critical for a serious endurance athlete. Sleep deprivation interferes with the pathways that control hunger and fullness. Sleep deprived individuals demonstrate a significant increase in daily hunger.

Sleep and Stress
The third consequence of sleep deprivation is an increase in cortisol levels. Cortisol is the “anti-recovery” hormone. High levels of cortisol increase muscle damage and reduce the repair and rebuilding of muscle protein. Normally, cortisol levels increase while we are sleeping reaching a peak at about 6:00 a.m. When we are sleep deprived, however, cortisol levels remain elevated. In one study, researchers found an increase in cortisol levels after sleep deprivation that lasted more than two days. Increased levels of cortisol lead to reduced muscle protein synthesis and increased protein degradation, and ultimately poor post-workout recovery.

What does this all mean to the time-challenged athlete? Getting sufficient sleep has to be a critical part of your training regimen. Cutting down on your sleep may give you more time to train, but it will make your training less effective. Research shows that you are better off training a little less yet more effectively by giving yourself the 7.5 hours of sleep you need every night.
THE MYTH OF LONG-ACTING CARBOHYDRATES

One of the more persistent myths in sports nutrition is the idea that long-acting carbohydrates offer an endurance advantage. This myth is perpetuated by the manufacturers of sports drinks and recovery drinks containing long-acting carbs, who trot out data showing that long-acting carbs provide a more sustained level of blood glucose than fast-acting carbs. Most educated consumers equate steady blood glucose with sustained energy.

Manufacturers rely on this association to suggest that, by providing sustained levels of blood glucose, their products containing long-acting carbs also delay fatigue better than products using fast-acting carbs. In fact, just the opposite is true.

Glycogen Depletion
Muscles contain a fixed amount of glycogen. When muscle glycogen stores are depleted, exercise performance declines very rapidly. The goal, therefore, is to preserve muscle glycogen as long as possible. In the 1960’s, researchers discovered that consuming beverages containing fast-acting carbs did just that. Fast-acting carbs are rapidly absorbed in the GI tract, rapidly transported to muscles cells, and rapidly metabolized to provide energy to working muscles. By providing an instant source of energy, fast-acting carbs preserve muscle glycogen, thereby extending endurance.

SLOWER METABOLISM
Long-acting carbs such as super starches, complex carbs and galactose are absorbed more slowly, and must be metabolically converted to fast-acting sugars before they can be transported to the muscles and used as energy. All this takes time, so the working muscles continue to deplete their limited supplies of muscle glycogen while they wait. The result is faster glycogen depletion and a quicker bonk than when fast-acting carbs are consumed. No study has ever been published showing long acting carbs extend endurance.

Long-acting carbs have their place in the diet of the endurance athlete. But that place is not during and immediately after exercise. Keep this in mind when selecting a sports or recovery drink.

THE RECOVERY WINDOW

Most athletes today recognize the importance of the recovery window, the 45-minutes post-exercise when key metabolic systems are activated.

Insulin is the time clock that controls how long the recovery window stays open. Insulin levels peak 30-45 minutes after exercise and then fall dramatically. When insulin levels rise multiple metabolic pathways are activated that determine the quality and speed of muscle recovery.

Insulin plays a vital role in replenishing depleted glycogen stores post exercise via two actions. One it transports sugar into the muscle, where is can be converted into glycogen. Two it activates the enzymes responsible for manufacturing glycogen.

The science of insulin creates a far different reality. No other mediator plays such a critical role in helping muscles recover. Understanding how insulin works and how to manage insulin can pay enormous dividends for endurance athletes.

THE MUSCLE RECOVERY MEDIATOR

There is a magic bullet that extends endurance, reduces muscle damage and builds lean body mass. No, it’s not growth hormone or some mystery anabolic agent, it’s insulin, the body’s ultimate recovery mediator. Because of its involvement in fat and sugar metabolism, insulin has gotten a bad rap in the popular and quasi scientific media as the cause of obesity, hunger and even poor endurance performance.

The science of insulin creates a far different reality. No other mediator plays such a critical role in helping muscles recover. Understanding how insulin works and how to manage insulin can pay enormous dividends for endurance athletes.

Stimulates Protein Synthesis
However, insulin exerts powerful effects on stimulating muscle protein growth and repair. An essential action of insulin is to increase the transport of amino acids, the building blocks of protein, into the muscle where they can be used for rebuilding and repair. Insulin also plays an important role in turning on one of the metabolic switches that control protein synthesis.

Two switches are responsible for turning on protein synthesis. One is activated by protein, specifically amino acid levels in the blood, and the second by insulin. Consuming carbohydrate (which raises insulin levels) and protein in your recovery drink gives you a dual benefit. In fact, research has shown that a carbohydrate protein drink is 38% more effective than a protein drink in stimulating muscle protein synthesis post exercise.

Inhibits Protein Breakdown
The third recovery effect of insulin is inhibition of protein breakdown. At any given time, muscle protein is in a state of flux – it is being synthesized and broken down. When more protein is synthesized than broken down, you have a net gain in lean body mass. After exercise, protein degradation is higher. That’s why consuming protein in your sports drink offers significant advantages. It reduces the amount of muscle protein used for energy. Higher breakdown rates of protein slows the overall recovery process. By inhibiting protein breakdown, insulin mediates a faster recovery.

The bottom line — by taking advantage of how and when insulin works and how nutrition can affect insulin activity, triathletes can optimize muscle recovery and achieve significant improvements in endurance performance.
There is a spirited argument among exercise physiologists about the causes of fatigue. Thirty years ago, scientists believed that fatigue was caused primarily by the buildup of lactic acid in the muscles. However, research conducted over the last five years has revealed that the causes of fatigue are far more complex.

**Two Components of Fatigue**

There is general agreement that fatigue has two components: a muscle component and a brain component. The question is whether they act in concert or independently. The best available evidence strongly suggests that fatigue begins in the muscles. If it’s true that muscle is the primary source of fatigue, then the triathlete has a number of nutritional strategies at his disposal to minimize, or, at the very least, delay the onset of fatigue.

As muscles work harder to generate the energy required for muscle contraction, there is a natural change in the levels of four critical components:

1. **GLYCOGEN**
2. **FREE RADICALS**
3. **pH**
4. **BRANCHED-CHAIN AMINO ACIDS**

The changes in these four constituents initiate a series of physiological and biochemical responses that cause fatigue.

Glycogen is the form in which muscles store energy. Glycogen supplies in the muscles are limited. When glycogen falls to a critical level, the muscle begins to lose its ability to maintain energy output and we bonk. To preserve glycogen and stave off the bonk, the muscle cell increases its use of blood glucose as an energy source. Since glucose is the brain cells’ primary energy source, any drop in circulating glucose impacts the brain, making us feel more tired. A drop in blood glucose also causes a release in the brain of IL-6, an immune regulator that has been shown to increase feelings of fatigue.

**Free Radicals & Muscle Damage**

We all know about free radicals. These are highly reactive molecules that can damage muscle proteins and are one of the causes of post-exercise muscle soreness. Free radical buildup is a natural consequence of exercise. The more oxygen we breathe, the more free radicals we produce. Free radicals cause fatigue in three ways. First, free-radical buildup interferes with the mechanism responsible for maintaining oxygen and nutrient delivery to the muscles. Second, free radical formation also interferes with the mechanism that controls muscle contraction. Third, the muscle damage generated by free radicals may release brain fatigue signals.

During exercise blood pH is lowered when the muscle is forced to generate energy in the absence of cellular oxygen. This process produces lactic acid which at one time was believed to cause a lowering of blood pH and generate feeling of fatigue. We now know that the pH effect is a result of the energy producing reaction, not lactic acid. Regardless, a lowering of blood pH produces multiple symptoms associated with fatigue such as muscle burning, and reduced muscle capacity.

**BCAA and Fatigue**

Branched-chain amino acids, of which there are three—leucine, isoleucine and valine—are highly concentrated in muscle cells. Unlike most amino acids, branched-chain amino acids can be efficiently utilized by muscles as an energy source. In fact, during extended exercise, up to 20% of the muscles’ energy may come from branched-chain amino acids, particularly leucine.

As branched-chain amino acid stores are used up, their blood concentration falls, which sets in motion the release in the brain of a neurotransmitter called 5HT. 5HT is often called the “fatigue hormone” since it creates a feeling of tiredness.

Although more research is needed to complete the picture, it is certainly clear that changes in these four key constituents, which are a direct result of increased muscle metabolism, can cause brain fatigue and bonking. This unified model of fatigue also gives us an excellent blueprint on how we can use nutrition to combat fatigue. The best anti-fatigue nutrition to consume during a workout is shown in the table below:

This brain-muscle nutritional strategy won’t guarantee that you won’t fatigue at all, but it certainly will have a positive impact in your next competition.

**IDEAL ANTI-FATIGUE FUEL**

- **Carbohydrate** in the form of high-glycemic sugars, such as sucrose, fructose and glucose (preferably two or more). High-glycemic sugars preserve muscle glycogen, maintain brain function during exercise and prevent the release of fatigue neurotransmitters.
- **Protein**, particularly protein high in branched-chain amino acids. BCAA’s serve as an additional source of muscle energy and prevent the release of fatigue signals from the brain.
- **Antioxidants** such as Vitamins E and C recharge the body’s natural antioxidant system, which is essential in maintaining normal muscle contraction and maintaining the mechanism responsible for nutrient delivery to the muscle.
Fluid balance and rehydration play critical roles in delaying fatigue and enhancing athletic performance. Rehydration has three components, 1) how fast fluids empty from the stomach, 2) the rate at which fluid is absorbed from the small intestine, and 3) how much fluid is retained after ingestion.

Q: Why Drink a Sport Drink?
A: For athletes, water is the most common rehydration beverage. And for millions of people who exercise at low to moderate intensity for shorter intervals of time, water is an ideal choice. However, for individuals who exercise more frequently at greater intensities, properly formulated sports drinks have been shown in research conducted over 40 years to be superior to water. The key is to take your hourly fluid needs and break it into six segments and drink one segment of fluid every 10 minutes. Of course we cannot ignore that certain activities, such as cycling, make it easier to drink more frequently.

Q: Do the Fluid Rules Change when it is Cold Out?
A: There’s a popular misconception that dehydration seldom occurs when exercising in the cold. That is just not true. Studies involving cross country and downhill skiers have shown dehydration does occur and it can negatively impact performance. It appears, however, that dehydration occurs differently when exercising in the cold vs. what normally happens during exercise in warm temperatures. In the summer, we feel the heat and sweat production is obvious and thirst mechanisms are activated. In the cold, however, our thirst mechanism is suppressed. A case in point is a recent study showing downhill skiers experienced significant dehydration during a morning of skiing, and yet were unable to rehydrate back to a normal range during a long lunch break even when given free access to fluids. Not only are the thirst mechanisms altered in cold, but we also experience greater water loss through breathing. This is due to breathing cold dry air, which forces our body to work harder to humidify and warm the cold air. Although most of the studies have been conducted in warm weather, cold weather dehydration can negatively impact performance. One study in skiers demonstrated that drinking water was more effective in reducing muscle stress compared to not drinking. This same study also reinforced the benefits of a sports drink. Ingestion of a carbohydrate protein sports drink not only was most effective in minimizing muscle stress, but was also shown to improve skiing performance.

shown that ingesting fluids in a metered way produces more effective rehydration and less GI upset than drinking large volumes. Drinking large volumes of fluid rapidly dilutes the blood leading to increased urine output. The key is to take your hourly fluid needs and break it into six segments and drink one segment of fluid every 10 minutes. Of course we cannot ignore that certain activities, such as cycling, make it easier to drink more frequently.

Q: Is it Better to Drink a Larger Volume or to Meter Fluid Intake?
A: In spite of the best prepared schedules, endurance athletes in the heat of competition often forget to drink on schedule. To compensate, they drink larger amounts in single gulps, which can lead to stomach discomfort – that feeling of sloshiness or fullness. And the large gulp strategy also leads to less effective rehydration. Researchers have

provide energy for muscle contraction, it was soon shown that carbohydrate actually improved rehydration. One ingredient, however, that was overlooked was protein, even though there was significant research showing that protein improved absorption of water. This led to the first sports drink that contained carbohydrate, protein and sodium. Our labs showed that the protein provided a synergistic effect to sodium and carbohydrate to enhance absorption as well as fluid retention over a conventional carbohydrate sports drink.

Dr. John Seifert, an associate professor at Montana State University and a leading researcher on the science of rehydration, offers tips on how to improve athletic performance.
One of most significant findings in sports science was the discovery of the post-exercise recovery interval. Researchers demonstrated that in the 45 minutes after exercise the metabolic pathways responsible for repairing, rebuilding and replenishing muscle cells were in a heightened state of activity. Consuming the right combination of carbohydrate and protein during this time vastly improved the quality and speed of muscle recovery. These findings have dramatically changed the post-workout nutrition regimen of endurance athletes and also raised the intriguing possibility that during the day there are other intervals when nutrient intake can be used to gain specific benefits from meeting the body's immediate metabolic needs.

Our Internal Clock
This is indeed the case. The key pathways responsible for controlling appetite, converting food into energy, reducing metabolic stress, and building muscle mass are not constantly set to the “on” position. To the contrary, each of these pathways has a unique metabolic rhythm that is programmed into our DNA. Anyone who has ever traveled through multiple time zones and felt the effects of sleeplessness, disorientation and loss of appetite is familiar with the circadian rhythm, our internal clock. What most athletes don’t realize, however, is that our internal clock also controls the metabolic pathways that determine our fitness level.

Once you understand how each of these metabolic pathways is programmed you can adjust the nutritional composition of your meals to allow these pathways to work in an ultra efficient mode. This is the core principle of a new concept called Functional Eating.

Functional Eating
Conventional eating plans assume that the body’s metabolic needs are fixed, so all you have to be concerned with is consuming a healthy ratio of carbohydrate, protein and fat over a 24-hour period. That is simply not the case and is metabolically counterproductive. For example, consuming a high-protein meal when energy needs are greatest will accelerate muscle fatigue.

Functional Eating recognizes and exploits our changing metabolic needs over the course of the day. Consuming the right combination of nutrients at the right time will give you more energy, reduce metabolic stress, increase the production of lean body mass and help you maintain your weight.

Recognizing how the body’s metabolic needs change over the course of the day is the first step to implementing a Functional Eating Plan. There are three primary functional intervals in the day:

7:00 A.M. to 9:00 A.M.
When you are sleeping your body calls upon energy reserves stored in muscle and fat cells to maintain minimal function. This involves cortisol. Just prior to daybreak, cortisol levels are highest. The morning interval is critical to reduce cortisol levels and prime your metabolic machinery.

9:00 A.M. – 5:00 P.M.
We are hardwired to be active during daylight hours. As a result, the metabolic machinery that converts food into energy is in a heightened state of activation during this interval.

5:00 P.M. – 11:00 P.M.
During this period of the day the pathways responsible for building and repairing protein are most active.

Functional Eating is not complicated. All you have to do is follow seven simple principles as shown.

Our bodies have remarkable metabolic capabilities. The challenge for endurance athletes is knowing how to realize this metabolic potential. Functional Eating is a powerful new tool to help triathletes do just that.

PRINCIPLES OF FUNCTIONAL EATING

1. Never skip breakfast. The ideal breakfast consists of about 80% carbs and 20% protein. This ratio will not only reduce cortisol levels but also replenish muscle energy stores depleted while you were sleeping.

2. Eat high-carbohydrate foods between 9:00 A.M. and 1:00 P.M. to ensure that the muscles and brain have sufficient energy.

3. Decrease consumption of carbohydrate-rich foods throughout the afternoon and evening.

4. Consume 55 percent of your daily calories by 1:00 P.M. to parallel the body's energy needs.

5. Eat high-protein foods between 5:00 P.M. and 8:00 P.M. The protein turnover circuit is most active during this period because it is not competing with the pathways responsible for generating energy.

6. Keep fat intake to a minimum in the morning and throughout most of the day, but increase your intake of healthy (mainly plant) fats in the evening. Since these fats are especially potent suppressors of hunger, this strategy helps keep you full in the period between dinner and bedtime.

7. Whatever time of day you work out, make sure you pay close attention to your fueling and recovery nutrition.
There is an energy crisis in this country, but it has nothing to do with oil, natural gas or solar. This one is personal. Because we live in a 24/7 world, fatigue has become one of the most common consumer complaints. This is particularly true for serious endurance athletes as they try to juggle the schedules of work, family and training. It is not surprising that energy product sales are over $10 billion per year.

Energy products seem to be an ideal solution by providing an added boost to help delay fatigue, improve concentration and mental focus. The ingredient bar for energy products is not very high. We know that caffeine plus carbohydrate provides quick energy and this combo is even more effective when protein is added. However, to differentiate energy products manufacturers add a long list of ingredients most of which have no effect on energy levels. B vitamins are a case in point. Some energy products have levels of B vitamins that are 8,000 percent of the recommended daily allowance even though there is no evidence that B vitamins provide an added energy boost. The only thing positive that we can say is there is also no evidence that high levels of B vitamins can harm you.

**Taurine and Energy**

Another ingredient found in most energy products is taurine, an amino acid normally found in the brain. Some companies, like Monster Energy® or Red Bull®, list the amount of taurine in their product separately. Others, like 5-hour Energy® take a less straightforward tactic and include taurine and caffeine as part of a so-called “energy complex”. This means they don’t have to specify the exact amount of each ingredient in the product.

The evidence supporting the use of taurine to boost energy largely comes from animal studies, which showed that when taurine was fed to rats they were able to swim longer than rats who did not receive taurine. However this type of study is often an unreliable predictor of what happens in humans and what happens when other ingredients are added. Sometimes the results are unexpected as is the case with taurine.

**Taurine Blunts Caffeine**

Two studies have evaluated the effect of taurine and caffeine, alone and in combination, on endurance performance and reaction time. Both studies arrived at a similar conclusion. When taurine is added to caffeine it actually blunts the energy enhancing effect of caffeine. A third study conducted by researchers from Montana State and presented at the American College of Sports Medicine annual meeting found that a taurine-containing energy product (5-hour Energy) was no better than a placebo in extending endurance, reducing fatigue, increasing reaction time and increasing alertness.

The reason why taurine blunts the effect of caffeine may be explained by studies on how taurine works. Within our brain, we have specific receptors responsible for increasing alertness and others for decreasing alertness. Taurine activates those receptors responsible for decreasing mental alertness.

So here’s the irony – energy manufacturers add multiple ingredients to their products under the marketing proposition that more is better. However, adding taurine cancels out the energy boosting effects of caffeine. When it comes to choosing an energy product, it pays to look at the ingredient list and, if the product contains taurine, you would be better served by having a glass of water. It’s cheaper.
CAFFEINE AND SPORTS PERFORMANCE

For many athletes, especially those who exercise in the morning, workout begins with a cup of coffee. For athletes and non-athletes alike, coffee jump starts their day. This caffeinated boost wakes us up and makes us more alert. With the proliferation of coffee shops on every corner and caffeinated products sold in grocery and convenience stores, we have become a caffeinated nation. Caffeine is the most widely used drug in the world.

Although the benefits of caffeine in endurance exercise were first reported over 30 years ago, new studies reveal that caffeine offers athletes so many advantages that it should become an integral part of their regular workout regimen. First and most important, caffeine is exceedingly safe. Even high levels of regular caffeine are not associated with any significant health risk. In fact, research is showing that caffeine may offer long-term health benefits in older people. Here are the latest facts about caffeine.

Caffeine Extends Endurance
The original research on caffeine in the 60’s suggested that caffeine improves endurance by sparing muscle glycogen. Your muscles contain a fixed amount of glycogen, the muscle’s energy source. When glycogen levels are depleted, you hit the wall or bonk. Caffeine may preserve muscle glycogen by increasing the use of fat as an energy source.

The latest research suggests that caffeine may extend endurance through different mechanisms. Scientists at the University of England in Birmingham found that when caffeine was combined with carbohydrate it stimulated the utilization of the carbohydrate in the sports drink as an energy source. The researchers also found that caffeine increased the absorption rate of the carbohydrate, which meant faster delivery to the muscle where it could be converted into energy.

Caffeine Reduces Brain Fatigue
We now know that the brain plays an important role in extending endurance. Fatigue signals emanating from the brain send a message to our muscles telling us we are tired and should stop. Caffeine, by blocking these specific signals, delays fatigue. The effect of caffeine on the brain may also explain Australian studies that found that caffeine consumed one hour before running sprints improves speed. In this case, caffeine may speed muscle contraction.

More Than Endurance
The benefits of caffeine are not limited to just endurance activities. English researchers found that consuming caffeine before a standard weight training regimen significantly delayed fatigue as measured by the number of repetitions. The researchers suggested that caffeine helps generate more forceful muscle contractions.

Even in team sports, caffeine was shown to improve performance. Soccer players consuming caffeine dribbled, headed and kicked the ball more accurately than when they didn’t consume caffeine.

The second myth is that caffeine causes GI problems. Since surveys show that 85% of runners have GI problems at least one during a year, the last thing they want to do is take a product that may exacerbate the issue. In a 2005 study, researchers found that although sports drinks cause more GI problems than water, sports drinks with caffeine caused no more problems than sports drinks without caffeine.

The Bottom Line
- Caffeine can significantly improve cycling performance
- Caffeine in doses up to 500mg is exceedingly safe for most individuals.
- Caffeine is more effective when combined with a carbohydrate or better yet a carbohydrate/protein combination.
MORE THAN
TWO DECADES OF INNOVATION AND DISCOVERY

1st Recovery Drink
Identified recovery window (45 minute interval post-exercise)

1st of 18 studies showing superiority of Endurox® R4® over other recovery

Landmark book highlights the role of timing

Study shows Accelerade® increases endurance 29% compared to carb-only drinks

Study shows Accelerade® more effective in rehydrating than water or carb-only drinks

Study shows Endurox® R4® activates dual signaling pathway for protein synthesis

1st protein-powered sports drink

1st protein-powered gel

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1st energy gel for brain and muscle fatigue

1st proven all natural energy shot

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Discovered the effect of a 4:1 carb-protein ratio on muscle recovery and performance.

Study shows AccelGel® increases endurance and reduces muscle damage vs. carb gel

Study shows Accelerade® reduces muscle damage by 83% vs. carb sports drink

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ACCELERADE®
THE PROTEIN-POWERED SPORTS DRINK

UNLEASH THE POWER OF PROTEIN.
When introduced in 2001, Accelerade®, with its patented 4:1 ratio of carbs and protein, represented a dramatic departure from conventional carb-only sports drinks. Accelerade also demolished the conventional dogma regarding the importance of protein to help fuel muscle cells and improve rehydration, the two essential criteria for a sports drink.

To date more than 10 peer-reviewed studies have shown that, compared to a conventional sports drink, Accelerade:

- Increases endurance by 29%  
- Decreases muscle damage by 83%  
- Increases rehydration by 15%  
- Increases endurance in a subsequent workout by 40%

Only Accelerade meets the total hydration, energy and nutritional needs of working muscles.

ACCELERADE® HYDRO™

MORE PERFORMANCE WITH LESS.
For less intense workouts, Accelerade® Hydro™ may be ideal. Accelerade Hydro contains the same patented 4:1 carb-protein ratio as Accelerade but has 55% less sugar and 30% less calories. However, you don’t compromise when selecting Accelerade Hydro. Researchers have shown that compared to a higher calorie carb-only sports drink, Accelerade Hydro increased endurance performance by 7%.

WORK HARDER, EASIER.
Every endurance athlete knows that the better you feel, the better you race. The reason has to do with perceived exertion. It’s no coincidence that perceived exertion is highest before you hit the wall, because high levels of perceived exertion actually produce fatigue. High levels of perceived exertion are caused by a drop in branched-chain amino acids (BCAAs) that trigger the release of fatigue signals in the brain.

Now, a study from James Madison University explains why athletes consuming Accelerade during exercise feel better even though they are exercising harder. The researchers found:

- Accelerade lowered the levels of perceived exertion  
- At the same level of intensity, athletes consuming Accelerade did not experience as much strain

By maintaining BCAA levels, protein-powered Accelerade minimizes the release of fatigue signals from the brain.

Accelerade Makes Your Hard Work Easier.

ACCEL GEL®
RAPID ENERGY GEL

KEEPS WORKING EVEN AFTER YOUR WORKOUT ENDS.
Accel Gel® is the first energy gel specifically designed to deliver rapid energy to working muscles. What makes Accel Gel unique is that it is the only gel that contains the patented 4:1 ratio of carb and protein and it uses a combination of three carbohydrates to maximize energy transport and uptake into muscle cells. This novel combination guarantees instant energy when you need it.

The superiority of Accel Gel was shown in a study published in the *Journal of Strength and Conditioning Research*. James Madison University researchers found that Accel Gel offers significant advantages compared to GU®, a leading carbohydrate gel, both during and after exercise. Researchers found that cyclists using Accel Gel had:

- **13% MORE ENDURANCE**
  - Accel Gel®
  - GU

- **50% LESS MUSCLE DAMAGE**
  - Accel Gel®
  - GU

GU
Accel Gel®
Endurance (Min)

GU
Accel Gel®
Muscle Damage

ACCEL GEL®
• Increase the delivery of cortical nutrients to brain and muscle cells
• Maintain metabolic energy needs
• Inhibit the release of fatigue signals in the brain
• Reduce muscle damage, an important trigger for release of fatigue signals
• Gives you added energy when you need it most


2ND SURGE™
ULTRA ENERGY GEL

THE FINISH LINE JUST GOT CLOSER.
Bonking. Hitting the wall. Blowing up. What causes extreme fatigue? Researchers have identified two fatigue centers; one in the brain, the other in muscles.

2nd Surge™ is the first all natural energy gel specifically formulated to delay the onset of both muscle and brain fatigue. The proprietary formula of rapidly acting carbohydrates, proteins, caffeine and antioxidants are proven to:

- Increase the delivery of cortical nutrients to brain and muscle cells
- Maintain metabolic energy needs
- Inhibit the release of fatigue signals in the brain
- Reduce muscle damage, an important trigger for release of fatigue signals
- Gives you added energy when you need it most

Double Expresso, Chocolate, Pina Colada

Chocolate with caffeine, Raspberry Cream with caffeine, Vanilla, Key Lime, Strawberry Kiwi, Citrus Orange

Developed by a leading exercise scientist, Body Glove SURGE® is the first proven all-natural energy shot containing protein, green tea and pomegranate. Body Glove SURGE recharges muscle energy stores, reduces mind and muscle fatigue and even speeds recovery. Studies conducted at Montana State University showed Body Glove SURGE significantly outperformed the leading energy shot.

WORKS LONGER.

Twice as effective as 5-hour Energy® after two hours.

WORKS FASTER.

Reduces Fatigue

Increases Mental Focus

ALL NATURAL.

No artificial ingredients. No chemicals.

Ingredients

Green Tea
Green Coffee Bean
Protein
Honey
Agave

Coconut Water
Grape
Pomegranate
Mangosteen
Cranberry

Chokeberry
Apple
Bilberry

UNCOMPROMISINGLY EFFECTIVE.

Endurox® R4® revolutionized the nutritional approach to muscle recovery. Over the last decade more than 18 peer-reviewed studies have demonstrated the superiority of Endurox R4® with the patented 4 to 1 carb-protein ratio. No other recovery drink has even one study behind it. These studies show that, compared to conventional recovery drinks, Endurox R4:

- Increases glycogen replenishment by 128%
- Decreases muscle damage by 36%
- Increases protein synthesis by 400%
- Increases endurance by 55% in subsequent workout

Endurox R4® is the #1 recovery drink for serious athletes in all sports. If you’re not already using Endurox R4®, better hope your competition isn’t either.

LESS PAIN, MORE GAIN.

Post-exercise muscle damage is the primary barrier between your workout and your goals. Endurox R4® is the only recovery drink proven to reduce muscle damage and increase both muscle function and endurance in a subsequent workout.

Investigators for James Madison University conducted a series of studies measuring the impact of recovery beverages on muscle disruption and subsequent muscle performance. The researchers found that Endurox R4®, compared to a carb-only drink:

- Reduced short-term muscle fiber damage by 42%
- Reduced longer-term muscle damage by 47%

And not surprisingly, these reductions in muscle damage translated to:

- 40% increase in endurance performance 16 hours later
- 14% increase in muscle function 24 hours later

ACCEL RECOVER™

WE RAISED THE BAR ON BARS.

Accel RECOVER™ was developed by leading exercise physiologists whose cutting-edge research has defined the science of muscle recovery. The goal was to create a great-tasting bar in which every nutritional component contributed to muscle recovery. All natural Accel RECOVER is the most exciting advance in bar nutrition in 30 years with a breakthrough formula that incorporates:

• Unique blend of three carbohydrates to rapidly and completely replenish depleted muscle glycogen stores

• Proprietary combination of three proteins enriched with glutamine, arginine and leucine, the amino acids that drive the repair and rebuilding of muscle protein and the rapid transport of nutrients to muscles

• Medium-chain triglycerides, which rapidly convert into energy rather than fat. No other bar uses MCTs as the primary fat source

• Antioxidants to protect your muscles from free radical damage

And we didn’t forget about taste. Chocolate Peanut Butter Accel RECOVER may be the best-tasting bar you have ever eaten, and that could be the biggest breakthrough of all.

ENGINEERED FOR MAXIMUM MUSCLE RECOVERY.

No other bar mobilizes the breadth of metabolic activities for total muscle recovery.

<table>
<thead>
<tr>
<th>Function</th>
<th>Combination of three proteins enriched with arginine, leucine and glutamine</th>
<th>Combination of three fast acting carbohydrates</th>
<th>Patented 4:1 ratio of carbohydrate to protein</th>
<th>Medium Chain Triglycerides (MCT)</th>
<th>Powerful anti-oxidants</th>
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<tbody>
<tr>
<td>Replenish glycogen</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>Stimulate protein synthesis</td>
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<td>Increase amino acid transport</td>
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<td>Support immune function</td>
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<td>Reduce muscle damage</td>
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<td>Blunt cortisol</td>
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<td>Prevent protein breakdown</td>
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Conventional Fats

• Converted into body fat
• Are not readily available for muscle energy
• Inhibit replenishment of muscle glycogen

Medium Chain Triglycerides (MCT)

• Converted rapidly and directly into muscle energy
• Speeds muscle recovery

Chocolate Peanut Butter

MAKE EVERY WORKOUT COUNT.

Adapogens are Chinese herbs shown to have remarkable effects in bolstering the immune system and improving endurance. Used for over 1,700 years, ciwujia, the ingredient in Endurox® Excel®, is considered the most effective of all adaptogens. Researchers at the University of North Texas evaluated the effect of ciwujia during exercise and found Endurox Excel:

- Decreased lactic acid levels by 13%
- Increased fat utilization by 43.2%
- Lowered heart rate during moderate exercise

In a 28 day trial with runners, published in the official journal of the American College of Sports Medicine, researchers found ciwujia increased endurance, VO₂ max and fat utilization. The bottom line - Endurox Excel works.

Compare Endurox Excel® to Optygen®

<table>
<thead>
<tr>
<th>CLAIM</th>
<th>ENDUROX EXCEL</th>
<th>OPTYGEN</th>
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<tbody>
<tr>
<td>Increase in fat oxidation</td>
<td>Proven in published study</td>
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<tr>
<td>Decrease in lactic acid</td>
<td>Proven in published study</td>
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<tr>
<td>Increase in VO₂ max</td>
<td>Proven in published study</td>
<td>No published study</td>
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<tr>
<td>Positive effect on immune system</td>
<td>Proven in published study</td>
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<tr>
<td>Suggested Price/30 day supply</td>
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</table>

More Performance For Less.
To develop your personal nutrition plan visit the Portman Calculator at WWW.PORTMANCALCULATOR.COM

The Portman Calculator allows you to easily compute your nutrition and hydration needs for your workouts or races. The Calculator determines the amount of fluid and nutrition you need to consume before, during and after your activity for optimum exercise performance. There are two types of calculators: An **EXERCISE CALCULATOR** that enables you to compute your nutrition and hydration needs for a wide range of activities and a **TRIATHLON CALCULATOR** that enables you to determine your race course nutrition needs.

Please enter your information below:

<table>
<thead>
<tr>
<th>Triathlon</th>
<th>Select Triathlon Type ▼</th>
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<tr>
<td>Estimated Swim Time:</td>
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<td>Estimated Bike Time:</td>
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<td>Estimated Run Time:</td>
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<tr>
<td>Your Weight:</td>
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**GO**

Visit us at www.pacifichealthlabs.com to obtain information on our latest products, cutting edge research in sports nutrition, and detailed guides to incorporate our products into your training program.