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Energy Channeling For Ultimate Sports Performance

by John Parrillo

You already know that using CapTri is a great way to lose fat and get in shape. What you may not know is how to use CapTri to improve sports performance. In the most basic sense, sports performance is about muscle power output. The ability of a muscle to produce power is limited by it's available fuel supply. Specifically, muscle power production is closely related to carbohydrate availability. There is a close correlation between muscle glycogen depletion and muscle exhaustion. The problem is, your body can only store so much glycogen. When it's used up, you "hit the wall," as endurance athletes understand all too well.

For all but the most relaxed of exercises (such as walking), carbohydrate is the muscle's preferred fuel substrate (energy source). Muscles can in fact use carbohydrate, fat, and amino acids as fuel, but these different fuel sources are not equally effective. Carbohydrate can be stored as glycogen right inside the muscle and is immediately available for use as fuel. For brief periods of time (one or two minutes) carbohydrates can be utilized to provide energy without the benefit of oxygen. This is known as "anaerobic metabolism," and can provide short bursts of energy for very intense exercise activity, such as weight lifting. Fats play an important role in energy production during prolonged exercise. However, there are two problems with fat as an exercise fuel. First, fat requires oxygen to be converted into energy - there is no anaerobic metabolism of fat. This means that the rate of energy production from fat is limited by the rate of oxygen delivery to muscles. Second, your muscles can store relatively little fat inside them, so before fatty acids can be burned by muscles they have to be imported from somewhere else. You may have noticed that most fat in humans is stored around the waist and hips, not inside muscles (too bad). This means that fatty acid utilization is also limited by delivery of fatty acids to muscles. The slowest step in transporting fatty acids from your waist to your muscles is the initial release of fatty acids from fat cells in adipose stores. This is a relatively slow process and only occurs at a significant rate when carbohydrate energy stores are already depleted. Before much fat is released from adipose tissue, blood sugar levels must drop, causing a decrease in insulin and an increase in glucagon and catecholamines. The catecholamine norepinephrine (a cousin of epinephrine, or adrenaline) is released from sympathetic nerve endings around fat cells and is the most potent stimulus for fatty acid release.

Obviously, fatty acid utilization is a complicated process and is relatively slow. Fatty acids can supply energy fast enough to keep up with the demands of walking or a slow bike ride, but any exercise more intense relies mainly on carbs as the primary fuel source. Your muscles can also use their own amino acids as fuel (God forbid) but this is a real last resort. After glycogen stores are essentially depleted and fatty acid metabolism is in high gear, amino acid metabolism kicks in to supply a little extra energy. During a long run, amino acid oxidation can account for up to 5-10% of energy substrate, which equates to about 50 grams of protein. This is undesirable (to make the understatement of the year).

Weight lifting is an anaerobic exercise which relies almost exclusively on carbohydrate as an energy source. (This is one reason the high fat - low carb diet doesn't make much sense to me.) Simply put, fatty acid metabolism is just too slow to meet the energy demands of resistance training. Similarly, intense endurance exercise is also limited by carbohydrate availability. Time to exhaustion in endurance exercise is closely related to muscle glycogen depletion. When an endurance athlete runs out of glycogen he doesn't have to stop, but he will slow down dramatically. The primary role of fat as an exercise fuel is to allow athletes to complete prolonged workouts. It does this by reducing the rate of glycogen utilization by muscle and thereby delaying the onset of exhaustion (1). In other

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words, an increased supply and oxidation of fatty acids will slow the rate of glycogen depletion and improve endurance.

The question is, how do we deliver greater amounts of fatty acids to muscle during exercise? Fatty acids stored in body fat tissue don't work very well for this purpose. As explained above, these fats are not released from body stores to a significant degree until carbohydrate reserves are substantially depleted. Obviously, this won't help since what we're trying to do is slow the depletion of body carbohydrate stores in the first place. Another approach is to consume a high fat diet. Believe it or not, this has been tried and is called "fat loading" (2). As you might imagine, it doesn't work very well, unless your idea of fat loading is just to get fat. Apparently conventional dietary fat is digested and absorbed too slowly to really be of much help. The answer is to supplement the diet with medium chain fatty acids. These special fats are digested and absorbed much faster than regular fat, in fact as fast as glucose (1,3). The rapid absorption and metabolism of MCFAs provides an energy substrate that can effectively spare glycogen and delay the onset of fatigue during prolonged intense exercise.

Glycerol is a small three carbon compound which can bind fatty acids, one fatty acid to each of it's carbon atoms. When long fatty acids (16-18 carbon atoms in length) are bound, this is called a long chain triglyceride (LCT). Everyday vegetable oils are long chain triglycerides. If medium chain fatty acids (8 to 10 carbon atoms in length) are bound, this is called a medium chain triglyceride (MCT). Conventional fats (LCTs) are very insoluble in water. This makes them hard to digest and transport. Inside the intestine, long chain triglycerides are cleaved from their glycerol backbone by an enzyme called pancreatic lipase. The long chain fatty acids (LCFAs) are then bound by bile salts (produced by the liver and stored in the gallbladder) for transport through the intestine. When you eat long chain fats they are not released directly into the bloodstream. Once absorbed inside an intestinal cell, the LCFAs are rebound to glycerol to re-form LCTs, which are then bound by proteins to make tiny particles called chylomicrons. The proteins act like detergent to make the fat more water soluble. The chylomicrons are released into the lymphatic system, another system of vessels in the body separate from the circulatory system. From there the lymphatic system delivers the chylomicrons to the bloodstream via the thoracic duct, which is located on the right side of your neck not far from your spine. The long chain fats are then circulated throughout your body by the bloodstream.

Most of these fat molecules are absorbed by fat cells and stored there. A few are delivered to muscle for use as fuel. This is a long complicated metabolic process that takes a long time. Importantly, please notice that the metabolic pathway followed by LCTs ends up by delivering them to fat cells for storage. Thus the old saying "fat makes you fat."

Medium chain fatty acids (MCFAs) skip this whole process. Since they are smaller fat molecules they are more water soluble and are therefore easier for the body to process. MCTs are released directly into the bloodstream by intestinal cells, without the need to be incorporated into chylomicrons and carried in the lymphatic system. Nutrient-rich blood leaving the intestine is carried directly to the liver by the portal vein for processing. The liver absorbs almost all of the MCTs from the portal blood and rapidly metabolizes them into ketone bodies. Ketone bodies are very small (two to four carbon atoms) molecules which represent partially broken down fatty acids. The ketone bodies are released from the liver into the bloodstream and are carried to muscles where they are immediately used for energy. This additional energy substrate (MCFA-derived ketone bodies) actually spares glucose oxidation. This delays glycogen depletion and the onset of muscular fatigue.

The process of MCT digestion, absorption, conversion into ketones, and transport to muscle takes place very rapidly. In fact, energy from MCFAs is available as fast as from glucose itself (1,3). This makes MCFAs the ideal energy source for athletes trying to push the envelop of endurance. Notice two other things that make CapTri the ideal fuel for athletes. First, CapTri is not delivered to fat cells for storage. As amazing as it sounds, medium chain triglycerides are not stored as fat. Instead they are preferentially burned as fuel. Does this mean you have "carte blanche" to eat as much as you want, and you won't get fat as long as you poor some CapTri on top of your food? Of course not. Too many calories will make you gain fat. The point is that conventional fats are preferentially stored as fat (that's the natural result of the metabolic pathway they follow) whereas CapTri is preferentially burned as energy. This means that if you eat a clean diet which includes CapTri you will find it very difficult to gain fat. It's harder for your body to store CapTri as fat than it is to convert carbohydrate into fat. Between conventional fat, CapTri, and carbohydrate, CapTri has the least tendency to be stored as body fat. For any given level of caloric intake, you will have less body fat the more CapTri you are using.

The other fact that makes CapTri the ideal energy supplement for athletes is that MCFAs don't
require the carnitine shuttle for transport

inside mitochondria. Mitochondria are the power plants inside cells where food molecules are burned to produce cellular energy. Regular fat molecules have to be carried inside the mitochondria by the carnitine shuttle. The problem is, the carnitine shuttle is not very active until carbohydrate stores are significantly depleted. Carbohydrate metabolism generates a metabolite called malonyl-CoA which inhibits the activity of the carnitine shuttle. Therefore, utilization of conventional fats is severely limited at two places: the release of fatty acids from fat cells and the entry of fatty acids into mitochondria are both inhibited by carbohydrate. This is why regular fats don't work very well to spare glycogen and improve endurance. Regular fats can't be used as a significant energy source until the carbs are already used up, and then it's too late. CapTri bypasses both of these limitations.

While a great deal is known about MCFA metabolism, most of our thinking on MCFAs and exercise performance has been theoretical with little experimental data in humans to back it up. Until now. A study was performed using six normal subjects who exercised at 40% VO2 max for 60 minutes or 80% VO2 max for 30 minutes on two different occasions (1,4). (VO2 max describes exercise intensity in terms of percent of maximal oxygen consumption.) Either a LCFA or a MCFA was infused during the study. Using radioactive tracer techniques, the authors were able to calculate the percent of LCFA or MCFA oxidized (burned) during the exercise. Total free fatty acid concentration was kept the same between the two trials. When the exercise intensity was increased from 40% to 80%, the oxidation of LCFA remained unchanged, while MCFA utilization increased significantly. It was concluded that entry of LCFAs into the mitochondria is limited (presumably by the carnitine shuttle) so that oxidation of LCFAs cannot keep up with the increased energy demands of high intensity exercise. On the other hand, MCFAs are readily oxidized more rapidly as energy demand increases. This is exactly what I have been saying for years.

Another study looked at the effects of MCFAs on carbohydrate metabolism and cycling performance (1,5). Six endurance trained cyclists rode at 60% peak VO2 for 2 hours and then performed a 40 km time trial on a laboratory cycling ergometer at 70-90% max on three separate occasions. Subjects drank an exercise drink consisting of glucose alone, glucose + MCFA, or MCFA alone. The authors found that the carbohydrate + MCFA drink significantly improved cycling performance compared to either glucose or MCFA alone. As expected, MCFA ingestion reduced glucose oxidation during the 2 hour pre-ride at 60% VO2 max, suggesting that the improvement in performance resulted from sparing of muscle glycogen by MCFA. Again, just what we expected.

These studies demonstrate three things about MCFAs and sports performance. First, MCFAs apparently work to improve performance by "sparing" muscle glycogen, thereby delaying the onset of fatigue. Second, the effect of MCFAs appears to be greatest during high intensity exercise. During low intensity exercise conventional fats appear to function adequately as an energy source. Third, the effects of MCFAs are likely to be more pronounced near the end of long endurance events (or at the end of long workouts for bodybuilders).

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What are some specific recommendations for how to use CapTri to improve athletic performance? First off, don't wait until the day of an athletic competition and then chug a bottle of CapTri right before your event. Big mistake. You'll puke and have diarrhea. At the same time. Not good. You need to start using CapTri several weeks out at a minimum, and a few months out would be better. Introduce CapTri into your system slowly, say one-half tablespoon per meal. Mix it with your food and don't take it by itself on an empty stomach. After a few days, increase your usage by one-half tablespoon per meal. Continue this until you build up to two to three tablespoons with each meal. Take a few days off from training before a competitive event and eat some extra carbohydrates (about 100 grams extra per meal). This will saturate your glycogen stores. The day of your event eat a complex carb for breakfast (oatmeal is probably ideal) along with one to two scoops of Hi-Protein Powder and three to four tablespoons of CapTri. This is probably the perfect pre-event meal. If you don't like competing with a full stomach, another approach which works quite well is to combine Pro-Carb Formula and CapTri to make a drink. Use one scoop Pro-Carb to one tablespoon CapTri. I'm not kidding, this combination is really quite remarkable. This makes a fantastic pre-workout drink for bodybuilders as well as a pre-event drink for endurance athletes. Finally, perhaps the most popular approach is the Parrillo BAR. It combines CapTri with a medium chain glucose polymer along with a high-efficiency protein source.

If you're serious about sports performance, you owe it to yourself to experiment with these nutritional techniques. This is cutting edge stuff, which is just beginning to appear in the scientific literature. We've been developing these techniques over the last few years, and I think you're going to hear a lot about it in the future. Endurance performance is limited largely by glycogen substrate availability. MCFAs allow us to channel an energy substrate directly to working muscle to spare glycogen and delay fatigue. This means improved performance - Parrillo Performance.

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Attention to Detail

by John Parrillo

Iron is required to build hemoglobin, the protein in red blood cells responsible for transporting oxygen to working muscles. Iron deficiency is the most common nutritional deficiency in the world, and is even more prevalent in athletes. Many children and adults have inadequate iron intakes. Only about 10% of dietary iron is absorbed. The form of iron found in red meat and liver is called heme iron and is more efficiently absorbed. Iron deficiency can lead to anemia, a condition where the body does not make enough hemoglobin. This results in decreased oxygen carrying capacity of the blood and impairs exercise performance. Athletes have a higher incidence of iron deficiency and anemia than the general population. Iron supplementation, especially in the form of heme iron, can correct iron deficiency and improve exercise performance.

Introduction

It's been several years since I've talked about iron supplementation. Vitamins and minerals aren't very glamorous, and nobody really gets too excited about them. They are however very important and should form the core of any supplement program. Iron deserves special attention because athletes are at increased risk for iron deficiency, and this can compromise exercise performance. What you need to know is not too complicated: take an iron supplement, preferably one made with heme iron. Alternatively, you can eat a lot of red meat, if you don't mind the fat, or you could eat a lot of liver, if you don't mind barfing.

Iron Requirements and Iron Deficiency

Daily iron losses by the adult male average about 1.0 mg per day. Losses through menses increases the iron requirements of women to about 1.4 mg per day. The amount of iron absorbed from food averages about 10%, so that means men need to consume 10 mg and women 14 mg per day.

When a person absorbs less iron than is lost, iron deficiency will result. If left uncorrected, this will eventually progress to anemia. Without enough iron, the body cannot manufacture enough hemoglobin. If you look at anemic blood in a microscope, the red blood cells are small (microcytic) and pale (hypochromic) because they don't contain enough hemoglobin. This condition reduces the oxygen carrying capacity of the blood. In order to meet the oxygen consumption demands of exercising muscle, the heart has to pump harder and faster to supply the tissues with a larger volume of oxygen-poor blood. (Since anemic blood contains less oxygen, the heart tries to compensate by pumping a larger volume of blood per minute.) During maximal exercise capacity the heart is already producing maximum cardiac output, so oxygen delivery is ultimately compromised (the heart can only compensate so much). This in turn puts an upper limit on exercise capacity.

> There is no question that iron deficiency anemia has a significant negative effect on oxygen uptake and exercise capacity (1). During maximal exercise, cardiac output cannot increase to compensate for reduced oxygen transport (1). That is, the heart is already at maximum output and cannot compensate any further.

How would you feel about training like a demon for six months, or longer, and being absolutely strict on your diet, only to have the top shaved off of your performance by less than optimal oxygen delivery? You thought you were doing everything right. Attention to detail is what separates first and second place. You think this is a rare problem and that you don't have to worry about it? Hardly. At least 11 studies have looked at iron deficiency in athletes (these are summarized in reference 1). I took the results of these studies and averaged them. According to these studies, 35% of female athletes and 10% of male athletes are iron deficient.

Iron deficiency and Performance

There is no question that iron deficiency anemia has a significant negative effect on oxygen uptake and exercise capacity (1). During maximal exercise, cardiac output cannot increase to compensate for reduced oxygen transport (1). That is, the heart is already at maximum output and cannot compensate any further. No one questions the reality of this effect. In fact, some endurance athletes use “blood doping” to improve exercise performance. This practice involves transfusion of blood one or two days prior to an event to increase hemoglobin concentration to above normal levels. A more sophisticated approach is to use erythropoetin. Erythropoetin is a hormone manufactured by the kidneys which stimulates the bone marrow to produce more red blood cells. Recently the gene for erythropoetin has been cloned and the hormone can now be produced in vitro (in a lab) and is available for use as an injectable drug.

What about mild iron deficiency which has not yet progressed to the extreme of frank anemia? Iron is required not only in hemoglobin, but also in myoglobin (an oxygen transport protein in muscle cells) and in several enzymes (including the cytochromes and others) which are involved in energy production. In one study, rats were made anemic by feeding them an iron deficient diet and then the anemia was corrected by blood transfusion. These rats still had decreased exercise capacity even though their anemia had been reversed, demonstrating that iron deficiency can negatively affect exercise performance in the absence of anemia (1). These iron deficient rats were found to have reduced enzyme activities in the energy producing pathway compared to normal rats. Studies in iron deficient humans have demonstrated that as little as 2 days of iron supplementation therapy can reduce heart rate during exercise, presumably by increasing oxygen carrying capacity of the blood and thus reducing the work required by the heart to supply oxygen to the body (1). Furthermore, iron deficient adults also have higher blood lactate levels following maximal exercise than subjects with normal hemoglobin concentrations (1). Lactate is a product of anaerobic metabolism, indicating that these individuals were not delivering enough oxygen to working muscles, or were not able to optimally produce energy from oxygen. So it appears that even mild iron deficiency which has not progressed to the point of anemia can also impair exercise performance.

Dietary Iron

Dietary iron sources are usually divided into two general categories: heme iron and nonheme iron (1). “Heme iron” is iron which is already bound to heme - the red pigment in hemoglobin. Good sources of heme iron are red meat and liver. White meat chicken and turkey breast also contain heme iron, but in lower amounts (2). The form of iron found in plants and conventional iron supplements (ferrous sulfate) is not incorporated into heme and is therefore called “nonheme iron.” Iron from red meat and liver, in the form of heme iron, is much easier for your body to absorb (1-4).

Iron deficiency is associated with vegetarian diets (1). Some vegetables such as beans, corn, and spinach contain a significant amount of iron. Unfortunately, iron from vegetable sources is poorly absorbed (1). For example, while spinach is relatively rich in iron, only 1.4% of iron from spinach is absorbed. Red meat provides much higher amounts of iron per serving than vegetable sources (2). And liver is an even better source of iron than red meat. Furthermore, the iron from red meat and liver - heme iron - is much easier for your body to absorb (1-4). About 15-35% of iron from red meat and liver is absorbed (1,2). The higher iron content of these foods, plus the greater bioavailability of heme iron, makes red meat and especially liver much better dietary iron sources.

About 2-8% of nonheme iron is absorbed, depending on the composition of the meal (1). Heme iron is chelated (ionically bound) to a special carrier molecule called a porphyrin, which is in turn bound to the protein hemoglobin. This complex improves iron absorption by the gut to around 15-35% (1). This makes it around 4 times more efficient (on average) as an iron supplement. Obviously, heme iron is the way to go.

Effects of Iron Supplementation

It has been extensively proven in many studies that iron supplementation will improve exercise performance in iron deficient anemic athletes (1). Studies of iron supplementation in iron deficient but not anemic individuals have yielded mixed results, some showing improvement and some showing no effect. The studies showing no effect were likely performed using subjects whose iron deficiency had not yet progressed to the point of impaired performance. “Iron status is a common cause of decreased exercise performance in humans, especially in women...It is strongly recommended for serious athletes, those whose performance has reached a plateau, and female endurance athletes to seek medical consultation for determination of iron status. If deficient in any way, iron repletion by dietary manipulation and/or iron supplementation is wise."

This is a direct quote from reference 1. (I couldn't have said it better myself.) The lab tests you'll need include a CBC (complete blood count), an iron level, ferritin level, and iron binding capacity. These tests are necessary to diagnose anemia and to prove whether or not the anemia is due to iron deficiency. The doctor's office visit will cost about $40.00 and the lab tests will cost about another $200.00 (give or take). While this is the scientific way to go, it turns out to be cheaper just to buy the iron supplement and give it a try. Unless you suspect some medical problem, this is what I generally recommend. You'll need to give it a trial of about three months to see if it works for you.

What is "Sports Anemia?"

Sports anemia is induced by exercise training - endurance athletes are especially at risk (2,3). Many times, sports anemia is not associated with a true iron deficiency. Skeletal muscle fibers are damaged during intense exercise training and this damage must be repaired during the recovery period following exercise. If dietary protein intake is inadequate, the body will draw on red blood cells, hemoglobin, and plasma proteins as a source of protein to repair the muscles (2,3). If protein intake is limited, repair of muscle tissue may soak up all of the incoming protein and not leave enough left to rebuild new red blood cells at the normal rate. Increased protein intake may be effective in treating sports-induced anemia (2,3). Often times, an athlete experiences a decrease in red blood cell count and serum iron levels during the early phase of training. This could be due to the fact that aerobic training causes an increase in myoglobin (an oxygen carrying protein) and cytochrome content of muscle tissue and the protein and iron required for their formation could be obtained from destruction of red blood cells. In other words, myoglobin (in muscle) may be increased at the expense of hemoglobin (in blood) if protein intake is inadequate. In summary, sports anemia is a form of anemia seen in hard training athletes who are often not iron deficient. Even though they are getting enough iron, they become anemic do to chronic protein deficiency (2,3). You can't build blood cells without protein.

What Should I Do?

The best iron supplement is one made from heme iron, because this is much more efficiently absorbed (1-4). The only type of supplement made using heme iron is desiccated liver. Parrillo Performance Liver Amino is made using a special extraction process which removes all of the fat and cholesterol which is found in liver. This is really the only way to get heme iron in a significant amount without getting a boatload of fat along with it. We've added a special protein to improve it's amino acid profile, making Liver Amino a source of high efficiency protein as well as heme iron. There is no other product like it on the market. It is also fortified with dibencozide, a superior form of B-12 which is better absorbed. It also contains other cofactors involved in blood production. To complete the picture you should also be taking Essential Vitamin Formula and Mineral-Electrolyte Formula. In addition to iron, you also need vitamin B-12 and folate to manufacture blood cells. Finally, an adequate protein intake is essential. If you're in a negative nitrogen balance, the other things probably won't be able to help. In summary you need heme iron, B-12, folate, and protein. Liver Amino should be considered a first line "essential" supplement for serious endurance athletes, especially women. Also, any women who are extremely lean, following a strict diet, or who are having menstrual irregularities should strongly consider this supplement.

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Endurance Performance, Part I

by John Parrillo

The specificity principle states that adaptations to exercise training are specific to the training stimulus applied. This means that athletes predominantly interested in muscle size and strength should focus most of their efforts on resistance training, and athletes interested in endurance performance should perform mostly endurance training. However, certain metabolic adaptations occur as a result of endurance training which are of great interest to bodybuilders as well as endurance athletes. These include increased oxidative capacity, increased work output, increased vascular supply to muscles, and increased fat oxidation.

Endurance training sessions should be performed a minimum of three days per week for 30-60 minutes at moderate to high intensity to achieve this training benefit. Some authors recommend low intensity aerobic exercise for fat loss, because at low intensity a greater percentage of utilized energy is derived from fat. While this is true, low intensity aerobic exercise is not effective in eliciting the metabolic adaptations which bring about a shift in energy substrate utilization patterns. Furthermore, low intensity aerobic exercise does relatively little to improve cardiovascular and respiratory fitness. While bodybuilders appropriately should focus their training on resistance exercise, they will achieve a higher degree of muscularity and leanness if they also include a component of vigorous aerobic exercise.

Introduction

Optimal endurance training is of great interest not only to endurance athletes but to bodybuilders as well. This series of articles will focus on how to use endurance training to help you achieve your physique goals. Aerobic exercise is the most effective way to lose body fat, and I'll explain how to train optimally to burn fat without sacrificing muscle. We'll also talk about ways to maximize your endurance performance.

General Principles

Two general concepts underpin any successful exercise training program. The Overload Principle describes the idea that an exercise stimulus must be of some threshold intensity to bring about a training adaptation (1,2). Exercise represents a form of stress, and the body adapts to that stress by getting stronger. To force the body to continue to adapt, the stimulus must continually become more intense. This is known as Progressive Overload. We can increase the training intensity by increasing the load (the resistance), the workout frequency, the workout duration, or the power output (work performed per unit time). The most effective way to produce increases in muscle size and strength is to increase the load. The most effective way to improve endurance performance is to increase workout duration. The best way to improve speed is to increase power output during the workout. The Overload Principle (sometimes called The Intensity Principle) applies to endurance training as well as to resistance exercise.

The Specificity Principle states that the metabolic adaptations that occur in response to a training stimulus are specific to the type of overload applied (1,2). Resistance training causes increases in muscle size and strength (if it's intense enough) and aerobic exercise causes improvements in cardiovascular endurance, with surprisingly little carry over between the two (1). Specific exercise elicits specific adaptations creating specific training effects (1).

Metabolic Adaptations

Aerobic conditioning results in metabolic adaptations that improve energy production (1). Mitochondria from skeletal muscle acquire a greatly increased capacity to generate ATP by oxidative phosphorylation. Mitochondria are the small furnaces inside cells where food is burned (oxidized) to produce energy. Oxidative phosphorylation is the biochemical pathway mitochondria use to combine fuel substrate molecules from food with oxygen, resulting in a release of energy which is used to form ATP. Aerobic training makes mitochondria more efficient at this process, which means they can make more ATP to power muscle fiber contractions. This is a benefit of aerobic exercise that you don't get from weight lifting. Associated with the increased capacity for mitochondrial oxygen uptake is an increase in the size and number of mitochondria and a potential two-fold increase in the level of aerobic energy producing enzyme systems (1). These adaptations are required to sustain a high percentage of aerobic capacity during prolonged exercise sessions. Animal studies have shown that skeletal muscle myoglobin can increase by as much as 80%. Myoglobin is a protein very similar to hemoglobin, except myoglobin is found in muscle cells while hemoglobin is found in red blood cells. Like hemoglobin, the function of myoglobin is to bind oxygen, and an increase in myoglobin can facilitate oxygen delivery to mitochondria.

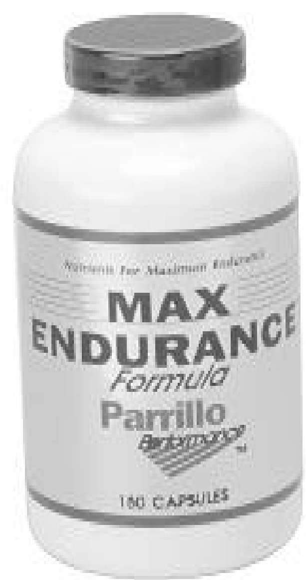
Aerobic training causes an increase in the muscle's ability to mobilize and oxidize fat. This occurs by an increase in blood flow within the muscle and in the activity of fat-mobilizing and fat-metabolizing enzymes (1). At any submaximal work rate, a trained individual uses more free fatty acids for energy than an untrained person (1,2). This is a key point and deserves some emphasis. Aerobic exercise training enhances the muscle's ability to use fat as a fuel source and causes a shift in energy substrate (fuel) selection such that the trained muscle learns to rely more on fat as an energy source and less on carbohydrate. This is important to endurance athletes because increased use of fat as an exercise fuel has a carbohydrate sparing effect - the more fat we can burn the longer the carbs will last. Since carbohydrate (glycogen) depletion is a major factor limiting endurance, this means improved performance. This is also very important to bodybuilders because it offers a way to shift your metabolism into a fat-burning mode. Aerobic training teaches your muscles to burn more fat and less carbs. This happens at rest as well as during submaximal exercise. (During maximal exercise, carbs are still the main fuel.) Notice what happens if you combine this approach with a very low fat diet. The aerobic training shifts your muscle's fuel selection into fat-burning mode, and your body becomes a fat burning machine. But there's no fat in your diet. So where does the fat come from to fuel your muscles? From stored body fat. By combining proper training and nutrition techniques you can teach your body to draw on its own stored fat as a primary energy source.

Cardiovascular and Respiratory Adaptations

The weight and volume of the heart increase with long-term aerobic training (1). This is characterized by an increase in the size of the left ventricular chamber and by a thickening of its walls. The left ventricle is the chamber of the heart which pumps blood out to the body, and intense exercise makes it get bigger and stronger, just like any other muscle. This means it can pump harder and deliver a larger volume of blood per minute to working muscles. This in turn means more oxygen delivery, more energy production, and more muscular power output. The heart's stroke volume increases significantly at rest and during exercise. Stroke volume is the volume of blood the left ventricle can eject in one beat. Since the left ventricle is larger and stronger, it can pump out more blood in a single beat than before training. Resting and submaximal heart rate are decreased during aerobic training. Since the heart can pump more blood with each beat, it doesn't need to beat as often and heart rate is decreased compared to before training. Plasma volume and total hemoglobin content of the blood increase with endurance training. This also improves oxygen delivery.

One of the most significant changes in cardiovascular function is an increase in maximal cardiac output (1,2). Cardiac output is the volume of blood the heart can pump in one minute. The increased cardiac output is mediated largely by the increase in stroke volume. Training also produces a significant increase in the amount of oxygen extracted from circulating blood (1,2). This is determined by measuring the oxygen concentration in arterial blood supplying a muscle and in venous blood leaving the muscle. The difference is referred to as the arteriovenous oxygen gradient, and it is increased by endurance training because the muscles become more efficient at extracting oxygen from the blood. This is probably due to the increased capillary supply of muscle fibers, as well as their increased myoglobin and mitochondrial content. Regular aerobic training reduces blood pressure. Endurance exercise increases the ventilatory capacity of the lungs by increasing both breathing frequency and tidal volume (the volume of air per breath). In submaximal exercise the trained athlete ventilates less than before training (marathon runners don't get out of breath from climbing a flight of stairs).

One of the most important adaptations to endurance exercise is an increase in the number of capillaries surrounding each muscle fiber (2). Endurance training can increase capillary density of muscles by 15% (and probably more, I suspect). This allows greater exchange of gases, heat, wastes, and nutrients between the blood and working muscle fibers (2). This facilitates not only energy production, but also fat metabolism and muscular growth. These increases occur within the first few weeks to months of aerobic training. If you want to grow big muscles, you need to deliver nutrients to them. The nutrients are delivered by capillaries. Do your aerobics.



VO2 Max

Endurance is a term that actually describes two separate components: muscular endurance and cardiorespiratory endurance. Muscular endurance is the ability of a muscle or muscle group to sustain high intensity repetitive exercise (2). Muscular endurance is highly related to muscular strength and anaerobic conditioning. An example is how many repetitions you can do with a given weight on the bench press. Technically speaking, strength is defined as your one rep maximum (1RM). Let's say your one rep max at bench is 225 pounds. That means you can probably do 185 pounds for 8 reps or so. If you train bench for several weeks at 185 pounds, pretty soon you'll be able to do 9 reps at 185. This is an increase in muscular endurance at 185 pounds. From a strictly technical point of view, this is not an increase in strength. To demonstrate an increase in strength, you need to increase your 1RM. Going from 8 reps at 185 pounds to 9 reps at 185 pounds probably won't increase your 1RM by much, if any. However, if you keep training soon you'll be able to do 12 reps at 185, then the next time you test your 1RM you'll find you can push up 230 with no problem. So while muscular strength and endurance are separate concepts, they are closely related. Another example of muscular endurance is a static muscular contraction, such as a wrestler trying to pin his opponent to the mat (2). Another example would be holding a leg extension in the fully extended position. Let's say you can hold a leg extension at 150 pounds fully extended for 10 seconds before you start to fail and lower the weight. After several weeks of training you may be able to hold it for 15 seconds. This is an increase in muscular endurance. (This technique, along with forced negatives, is in my bag of tricks for breaking through plateaus.)

Whereas muscular endurance refers to individual muscles, cardiorespiratory endurance refers to the body as a whole (2). It describes your body's overall ability to sustain prolonged rhythmic exercise. Rather than being limited by the endurance of a particular muscle, your cardiorespiratory endurance is limited by your body's energy producing ability, which is in turn limited by your ability to deliver oxygen to working muscle tissue, which is in turn limited by your cardiovascular and respiratory systems. Most exercise physiologists regard VO2 Max as the best indicator of cardiorespiratory endurance capacity (2). While strength, defined as the one rep maximum, is the best way to measure performance improvements in resistance training, VO2 Max is the best way to measure aerobic power (2). VO2 Max is defined as the highest rate of oxygen consumption attainable during maximal exhaustive exercise (2). You certainly can exercise at intensities higher than your VO2 Max, but this recruits the anaerobic energy producing pathways. After a minute or two at this intensity fatigue will set in and muscular failure will occur. Your VO2 Max represents the highest level of exercise intensity that you can sustain for a prolonged period of time. The VO2 Max dictates the rate of work or the pace you can sustain (2). Aerobic conditioning results in an average increase of 20% VO2 Max following six months of conditioning. This is brought about by a combination of two factors. An increase in cardiac output results in more blood, and thus more oxygen, being delivered to tissues. Second, an increase in the arteriovenous oxygen gradient means that more of this oxygen is being extracted from the blood by the muscle. This means that more oxygen is being used by the muscle to produce energy, and more energy production means more muscle power and endurance.

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Lactate Threshold

When glucose is metabolized anaerobically (without oxygen) it is converted to pyruvate and subsequently into lactate (lactic acid). Lactic acid buildup inside muscle cells is one of the factors that makes your muscles burn when you train a set of biceps curls to failure. At lower intensity exercise, you really don't recruit the anaerobic energy system because you don't need it. (Refer back to our series on cellular energy production.) During endurance exercise, your body can supply oxygen fast enough to the muscles so that you can produce all the energy you need from the oxidation of glucose and fat, without producing lactic acid. As exercise intensity increases, you eventually reach a level where the aerobic energy producing pathway is maxed out, and anaerobic energy production begins. At that point, lactate is produced inside muscle tissue and begins to appear in the blood as a waste product. The lactate threshold is the point where blood lactate begins to appear. Like VO2 Max, this is a measure of cardiorespiratory fitness. Endurance training increases the lactate threshold, which means a higher level of energy production can occur by the aerobic pathway before the anaerobic pathway is called into play. Trained endurance athletes can perform exercise at a higher VO2 Max before blood lactate appears. This means that they can exercise at a higher intensity (they can produce more power aerobically) before anaerobic metabolism begins.

At first it might sound like VO2 Max and lactate threshold are really two ways of measuring the same thing, but they're not. While they both reflect endurance performance, they are looking at different aspects. VO2 Max is a description of the maximal aerobic energy producing ability of an athlete. Lactate threshold describes the percentage of VO2 Max at which the athlete can train before anaerobic metabolism begins. The increase in lactate threshold, at a given percentage of VO2 Max, is probably due to a greater ability to clear lactate produced by the muscle (due to increased capillary density of the muscle tissue bed), an increase in skeletal muscle enzymes involved in aerobic energy production, and a shift in metabolic substrate to a fuel mix involving a higher proportion of energy derived from fat.

These concepts lay the basic ground work you need for a thorough understanding of endurance exercise physiology. Next month we'll talk about training intensity, respiratory quotient, fat metabolism, and specific strategies on how to incorporate endurance training into your program to maximize fat loss without losing muscle.

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Endurance Performance, Part II

by John Parrillo

To maximize fat burning during aerobic exercise you should do it first thing in the morning before breakfast or else right after weight training. During these times liver and muscle glycogen are relatively depleted and insulin levels are low. These conditions promote the use of body fat as a fuel source. Aerobic exercise should be performed at moderate intensity for 30 to 60 minutes per session, generally. A good way to gage intensity is that you should be breathing hard and sweating. For maximum fat loss, don't eat carbohydrates immediately before or during cardiovascular exercise. Even if your only goal is fat loss, it is important to include weight training as part of your exercise program. Also, don't restrict calories too much and be sure to get plenty of protein in your diet to help prevent muscle loss while burning fat. Consume a low fat diet to ensure that the fat you burn during your aerobic exercise is body fat and not dietary fat.

Scientific Background

Last month I explained the concepts of VO2 max and the lactate threshold. These are simply scientific ways of measuring cardiovascular fitness. Briefly, VO2 max is the body's maximum rate of oxygen consumption (1,2). This determines the maximal intensity of aerobic exercise which you can sustain. The lactate threshold is the percentage of VO2 max at which lactic acid first appears as a waste product in the blood (1,2). Lactic acid is a byproduct of anaerobic metabolism when glucose is broken down without oxygen. Thus the terms "lactate threshold" or "anaerobic threshold" are often used interchangeably. This represents the rate of energy production which can be sustained aerobically before the anaerobic pathways kick in.

These concepts may sound complicated but a simple example will make them clear. Let's take a sedentary person who hasn't exercised in years and put him on a training program. Initially he can only ride the stationary bike for 20 minutes at low intensity because he's so out of shape. After six months of consistent training he can ride for 20 minutes at high intensity. He has just increased his VO2 max, his maximal level of sustainable exercise. At the beginning of his training program if he tried to peddle against high resistance, after a few minutes his thighs would begin to burn and ache from lactic acid accumulation. After six months of training he can peddle for 20 minutes against high resistance with no thigh pain. He has just increased his lactate threshold.

An aerobic exercise training program will increase both VO2 max and anaerobic threshold. What does this mean? The meaning of an increase in VO2 max is pretty obvious: it means you can exercise harder. An increase in anaerobic threshold means that you can exercise at a higher percentage of your maximal ability before anaerobic metabolism begins to contribute to energy production. So not only can a trained athlete exercise harder, he can exercise more efficiently. He can exercise at a higher percentage of his maximal ability before the lactic acid burn begins to set in. That implies he can maintain a higher percentage of his maximal output for a longer time before reaching fatigue. So now you can see that VO2 max and anaerobic threshold describe somewhat

The meaning of an increase in VO2 max is............. you can exercise harder. An increase in anaerobic threshold means that you can exercise at a higher percentage of your maximal ability before anaerobic metabolism begins to contribute to energy production. So not only can a trained athlete exercise harder, he can exercise more efficiently. He can exercise at a higher percentage of his maximal ability before the lactic acid burn begins to set in. That implies he can maintain a higher percentage of his maximal output for a longer time before reaching fatigue.

different aspects of endurance performance. Another fundamental concept we need to understand is the respiratory quotient (RQ). This is defined as the ratio of carbon dioxide produced to oxygen consumed during energy production (1,2). What does this have to do with anything? It has everything to do with fat loss and body composition. Respiratory quotient is measured by analyzing the amount of oxygen a person extracts from the air and the amount of carbon dioxide he exhales into the atmosphere as he breathes. We can learn some very interesting things using this technique. It turns out that if a person is burning pure carbohydrate as his energy source the respiratory quotient is 1.0. If he is burning fat as his fuel source the respiratory quotient is 0.7. This difference comes from the fact that the carbon atoms in carbohydrate molecules are already partially oxidized (the carbon atoms are bound to oxygen in the sugar molecule). In fatty acids the carbon atoms are bound to hydrogen, and are said to be "reduced" (the chemical opposite of oxidized). It makes sense then that fat should contain more calories per gram than sugar, because in sugar the carbon atoms are already partially oxidized before you eat it. In a fatty acid molecule the carbon atoms are not oxidized at all, so when they are burned inside cells more energy is released per carbon atom than for glucose. Also, since the carbohydrate molecule already contains some oxygen atoms built into it, it takes fewer molecules of oxygen to complete its oxidation than for a fat molecule. This is the reason burning fat as your fuel source results in a different respiratory quotient than burning carbs. A typical mixed diet containing protein, carbs, and some fat results in a RQ around 0.8.

Whew! So what does this have to do with bodybuilding and fat loss? By measuring the RQ of people while they are exercising we can determine the fuel substrate which is being used. At rest and during sleep mostly fat is used as the body's fuel source. During low intensity exercise, such as walking or low intensity biking, still mostly fat is used. At the other extreme, during very high intensity exercise such as weight lifting the predominant fuel source is carbohydrate. And at moderate exercise intensity a mixture of fat and carbs is used for fuel. If you think about the biochemical pathways of energy production this makes perfect sense. High intensity exercise like weight lifting is primarily fueled by the anaerobic pathway. This is because the muscle's demand for energy is

so high that oxygen cannot be supplied to the muscle fast enough to keep up with the demand, so the muscle has to turn to anaerobic metabolism. Anaerobic metabolism can supply rapid bursts of energy very quickly, but cannot be sustained for a very long time. This is why you can ride the bike for hours but can only do squats for about a minute before you fatigue. The body can use carbohydrate as a fuel for anaerobic energy production (glucose is converted to pyruvate in the glycolytic pathway and pyruvate is subsequently converted to lactate). However, there is no such thing as anaerobic fat metabolism. Fat requires oxygen to be converted to usable energy. Simply put, you can't burn fat fast enough to keep up with the rigorous energy demands of intense weight lifting, so you have to use carbs. On the other hand, the oxidation of fat makes the perfect energy source for lower intensity exercise such as walking.

Many people use this rationale to advocate low intensity exercise (such as walking) as the ultimate exercise for fat loss. At first thought, this makes good sense. It is true that during low intensity exercise a higher percentage of the energy expended is derived from fat. The problem is that during low intensity exercise you burn very few calories, so even if almost all of the calories are derived from fat, that's still not much fat loss. During moderate intensity aerobic exercise, such as jogging or a brisk bike ride against moderate resistance, a higher percentage of the calories you burn come from carbs, but you burn so many more total calories that the overall result is still greater fat loss. So it's not just the percentage of energy derived from fat that's important, but also how many total fat calories you burn. If you do your aerobics at moderate to high intensity you will burn more carbs along with the fat, but you'll end up burning a greater amount of fat in the long run because you expend more calories.

To put this in perspective, don't let me leave you with the wrong message. Walking is a great exercise for fat loss, it's just that you'll have to walk for hours everyday to see really noticeable results. I'm not against walking, I just don't think it's the best choice for serious fat loss. Just as there are plateaus you encounter while gaining muscle, you will also hit plateaus during fat loss. Probably the best way to stimulate accelerated fat loss is to increase the intensity of your aerobics. In your own experience, who's leaner - the guy who walks three miles a day or the guy who runs three miles a day? The runners I know are leaner than the walkers. I've worked with a lot of bodybuilders who could never really get into contest shape until they started running.

Last month I talked about some of the metabolic adaptations that occur as a result of endurance training. One is an increase in the vascular supply to muscles. The harder the muscles are forced to work, the more blood they need. Another important adaptation is an increase in the fat-burning capacity of muscle cells. Endurance training causes an increase in the cellular content of mitochondria and enzymes responsible for burning fat. I don't think you get much of a metabolic adaptation to low intensity exercise. Sure, you can burn fat if you walk long enough, but you really won't increase your capillary density or beef up your fat-burning enzyme pathways significantly unless you train hard. The concept of intensity applies to endurance training just like it does to resistance training. If you want to see a big change in your body you have to force it to adapt by providing an intense training stimulus.

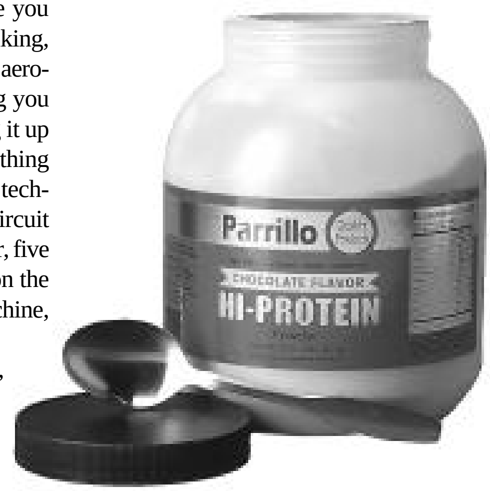
If you still don't believe me, just try it. It won't cost you anything and you have nothing to lose. Try doing low intensity aerobics for a month (walking) and measure your body composition before and after. Then do moderate to high intensity aerobics for a month (jogging or fairly strenuous biking) and again measure your body composition. You'll see. I've done this kind of thing with competitive bodybuilders about a zillion times, so I know what will happen.

Practical Applications

How do we put this all together to get the best results? Do moderate to high intensity aerobics for 30 to 60 continuous minutes a minimum of three days a week, and seven days a week is better. You should be breathing hard and sweating. Remember, fat metabolism requires oxygen. If you're not breathing hard you're not consuming much oxygen and so you can't be burning much fat. It's not that complicated. What about heart rate? If you want to measure heart rate, that's fine. Probably between 70-85% of your theoretical maximum heart rate is a good goal to both burn fat and accrue the metabolic adaptations of endurance training (increased capillary density and increased fat-burning machinery). Your theoretical maximum heart rate is 220 minus your age. This is a pretty crude way to do it however because how your heart rate responds to exercise depends on your level of training.

Do your aerobic exercise for at least 30 minutes per session. It takes a while to liberate fatty acids from adipose tissue and really start burning much fat. You probably don't burn much fat until about 15 minutes or so into the exercise session. Do your aerobics on an empty stomach. First thing in the morning before breakfast is a great time. Then your glycogen levels are somewhat depleted from your overnight fast and insulin levels are low. Since insulin blocks fat metabolism, aerobic exercise right after eating carbs is a bad idea. No carb drinks before or during your aerobics. Another good time to do your aerobics is right after weight training. The weight training depletes your glycogen levels so your body will be forced to burn fat instead of carbs. Also, weight training increases catecholamine levels (epinephrine and norepinephrine) which stimulate fat metabolism. So you'll start burning fat right from the start of your aerobic exercise session that way.

The particular type of exercise you do doesn't matter. Running, rowing, biking, stair climbing, skiing, in-line skating, and aerobics classes are all okay. Pick something you like and can stick with. I suggest mixing it up for variety. Just make sure you are breathing hard and try to work up a sweat. One technique to help keep the intensity up is circuit aerobics. Five minutes on the stair climber, five minutes on the treadmill, five minutes on the bike, and five minutes on the rowing machine, then repeat the circuit.



So we've covered the type of exercise, the training intensity, the training duration, the training frequency, and the timing of the training session. I can't close without talking a little about nutrition. There are four key points I'd like to make. First, don't cut calories too much. If you are faithful to the diet as outlined in the Nutrition Manual, you probably won't have to cut calories at all. If you eat according to the diet, do your weight training, and do your aerobics, you will automatically get lean without having to cut calories. If you do need to reduce calories, do so very modestly. Ten percent below your maintenance requirement is plenty. If you reduce calories too drastically you will lose muscle, and thereby decrease your metabolic rate and your ability to burn fat. Remember, muscle is the engine that burns fat. Maintaining muscle mass is a priority. Second, eat a low fat diet. The aerobics program as described here is designed to maximize fat burning. If you don't eat any fat in your diet, then the fat you burn during your aerobics has to come from stored body fat. If you have much fat in your diet then when you exercise you'll simply burn the fat you just ate. You'll be spinning your wheels and won't get leaner. If you burn fat during exercise, but don't eat fat, then you'll have to lose body fat. It's that simple. Third, get plenty of protein. This is key to preserving muscle mass while losing fat. During aerobic exercise, especially at high intensity, some of the fuel is derived from amino acids. This can result in muscle loss if you're not careful. I've had very good results using a scoop of Hi-Protein powder before aerobics. This supplies very little carbohydrate and does not raise insulin levels significantly. The Hi-Protein increases the blood levels of amino acids, so that any aminos which are oxidized during the exercise session are derived from the protein powder instead of being extracted from muscle tissue. Here's the strategy: if you exercise in the morning, get up and have a cup of coffee and a scoop of Hi-Protein powder, then do your aerobics. If you do your cardio work after weight training, then have a scoop of Hi-Protein between the weight training and the aerobics. This will prevent any loss of muscle tissue and will not inhibit fat metabolism. Fourth, follow your body composition. All serious bodybuilders follow their percent body fat and lean body mass. You have to in order to know what's going on with your body composition. Scale weight is just not enough. The Body-Stat Kit is an invaluable tool in this regard. It includes a detailed manual that explains how to modify your diet and exercise to keep things moving in the right direction, and discusses specific problems commonly encountered while dieting for contests.

Parrillo Performance. We're here to show you how.

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The Parrillo Performance Program

by John Parrillo

I think the basic strength of the Parrillo program, and why it has proven so successful with competitive bodybuilders over the years, is that it is based on solid fundamental principles. The core of the program is our approach to nutrition and training. Think about it. Nutrition and training is really what bodybuilding is all about. The Parrillo nutrition program works so well because it's based on solid nutrition from healthy bodybuilding foods, not the latest supplement fad. Not only is a proper diet and intense training the best way to attain bodybuilding success, it's the only way. It just doesn't matter how many high-tech supplements you take, if you're not eating right you won't get very good results.

Getting your diet in order in the first item of business. This is the foundation on which everything else is based. I've seen many bodybuilders attain excellent size and conditioning using only a minimal supplement program, but they were eating a lot of muscle building foods. Every week I get calls from young bodybuilders disappointed because the latest miracle supplement they tried just didn't seem to live up to their hopes. Usually it turns out they weren't eating a bodybuilding diet. They wonder why adding some supplement to the typical American diet didn't turn them into competitors. If you learn one thing from me, remember that food is the foundation of nutrition. Over the last few years a number of very expensive supplements have entered the market and sometimes people get discouraged because they can't afford to use them. Don't worry about this. You can achieve great results with just a strict diet and hard training. Many of the top bodybuilders use only a few supplements. Generally, if you spend more effort at eating right and trying to perfect your diet instead of worrying about supplements you'll be better off. Many supplement programs these days cost $200-$300 per month to follow. A one-time investment in a Parrillo Nutrition Manual will do more for you than a year's worth of supplements and costs practically nothing in comparison. In terms of results per dollar, the Parrillo Nutrition Manual is the most powerful bodybuilding tool on the planet.

> Thousands of athletes have realized great results utilizing the ideas and procedures that make up this program.

I've talked with countless people, in the hundreds if not the thousands, who have jumped around from supplement to supplement trying to find the magic formula that would work for them. Many of these bodybuilders have struggled in the gym for years with only minimal results. When one of these guys calls for advice, and it happens every day, I suggest the following experiment. For one month don't buy any supplements. Take the money you would normally spend on supplements and buy a Parrillo Nutrition Manual instead. Read it. Follow it without exception, every meal, every day, for a month. See what happens. What have you lost? Nothing really, since the supplements weren't producing good results anyway. Plus, at the end of the month you still have the Nutrition Manual. Many of these people are absolutely amazed at what they can accomplish in one month. Most people drop a couple of pounds of fat and gain a couple pounds of muscle just by switching onto the diet - and that's without supplements! Many people see more progress in this one month than they have in the last year. And the key is, you can keep doing it month after month. If you buy $100 worth of supplements and take them, then that's all you get. After you get on the right diet, you will find that you need fewer supplements and that you get much more benefit from the supplements you do use.

Be sure, when you go on the Parrillo diet you will be making some changes. It's a major lifestyle modification for most people. It's a strict program. It's definitely not for everybody. It's for people who are willing to work, to make sacrifices, and to do what it takes to look like a bodybuilder. It's tough, but it works.

Here's what you do. Start by consuming one gram of complete protein per pound of body weight each day. Next, limit fat to 5-10% of calories consumed. Finally, the remainder of your calories are derived from complex carbohydrates. How many calories should you eat? Start recording your daily weight and write down everything you eat in a nutrition journal. Measure your food portions so you can calculate how many calories you eat in a day. Initially don't make any special effort to gain or lose weight, just concentrate on following the diet strictly. After a week or two of keeping records you'll see how many calories you eat each day on average. If your body weight doesn't change during this period this is your "maintenance energy requirement," the number of calories required to maintain your present body weight. To gain weight, add 300-500 calories a day. To lose weight, eat 300-500 calories a day less or do an extra 30 minutes of cardiovascular exercise.

You'll notice that most of the adjustment in diet composition has to do with carbohydrate intake. Your protein requirement is determined primarily by your body weight. If you add extra calories to gain weight, these are supplied by more complex carbs. Extra carbs seem to work best for gaining lean mass. If you reduce calories to lose fat, you're still consuming the same amount of protein. The calories are reduced by reducing carbs. The way the diet is structured automatically changes the ratio of protein to carbohydrate in the diet. This has been shown to change the ratio of insulin to glucagon in the blood (1) which in turn has an impact on nutrient partitioning and body weight set point (2). The Parrillo diet was designed with a lot of thought as to using food to manipulate hormones in the body to channel nutrients into certain metabolic pathways. The diet is engineered to channel nutrients toward the lean body compartment while partitioning energy away from fat stores. You don't have to be a biochemist to get the results, you just have the follow the diet strictly. To the letter.

Let's talk about a few specifics. What is a "complete" protein? This is a protein source which supplies all of the amino acids, including the ones which cannot be manufactured by the body. These are the so-called "essential" amino acids. Complete proteins supply all of the amino acids you need to build new muscle tissue, making them the best protein choices for bodybuilders. Examples of good low-fat protein sources are egg whites, chicken and turkey breast, and many fishes. These should form the basis of your protein choices.

Complex carbohydrates fall into two general categories: starchy and fibrous. Starchy carbs are things like potatoes, sweet potatoes, rice, beans, oatmeal, corn, and peas. Vibrous vegetables are salad greens, broccoli, green beans, carrots, and so on. You should include both starchy and fibrous carbs at each meal.

Each meal should be constructed according to the formula described above. Don't eat just protein at one meal and just carbs at another. Combining protein and carbs and fiber together in the same meal slows the release of glucose into the bloodstream, helping keep insulin levels from getting too high. This helps channel nutrients to muscle instead of fat. When insulin levels are too high, this stimulates fat storage. Be sure to divide your daily allotment of calories roughly evenly into six small meals. This also provides for better insulin control and also continually bathes the muscle in a nutrient rich environment so growth can proceed continuously.

Again, concentrate your effort on following the diet. Spend as much time thinking about groceries as you used to spend trying to decide which supplements to try. Remember, groceries work better than supplements. Your body was made to eat food. That's what it needs and that's what works best.

You will find the Parrillo Nutrition Program shifts your metabolism into fat burning mode. Your body uses a certain amount of fat as fuel every day. Fat is used as a prime fuel source while at rest and is also used during cardiovascular exercise. If you consume less fat in your diet than you burn every day, that extra fat must be obtained from body fat stores.

You will find the Parrillo Nutrition Program shifts your metabolism into fat burning mode. Your body uses a certain amount of fat as fuel every day. Fat is used as a prime fuel source while at rest and is also used during cardiovascular exercise. If you consume less fat in your diet than you burn every day, that extra fat must be obtained from body fat stores. This simple sounding concept has caused quite a stir in the metabolism literature recently. Over the last few years it has become clear that what we really care about is not energy balance (calories in versus calories out) but rather fat balance (3,4,5). We want to burn more fat than we eat every day to achieve loss of body fat. Energy balance is not as important as fat balance. Last month I explained the concept of respiratory quotient (RQ). This is a way to determine to composition of the fuel mix the body is burning at a given time. Generally speaking, the body's energy needs are met by oxidizing a mixture of fat and carbohydrate. In the same way we can define the fuel quotient (FQ). It has been determined that in order for loss of body fat to occur the RQ must be less than FQ. What does this mean? Simply that if you eat less fat than you burn then you'll lose body fat (3,4,5). It's that simple. This works because it turns out that under normal conditions your body converts very little (in fact, practically none) protein or carbohydrate into body fat (6). That's right - almost all body fat is derived directly from dietary fat. Excess dietary carbohydrate has very little tendency to be converted into fat and stored as body fat (6). Over-feeding as much as 500 grams of carbohydrate results in only a couple of grams of fat storage (6). On the other hand, if excess calories in the diet are supplied as fat, they have a very strong tendency to be stored as body fat. In summary, quite a bit of recent research in metabolism has indicated that the fat content of the diet is at least as important, if not more important, than how many calories you eat. As an example, you could eat only a modest number of calories, but if those calories are supplied in a form prone to be stored as fat, then you'll get fat. Alternatively, if you eat foods which are very difficult for the body to convert into fat, then you can eat a lot of calories without getting fat. Sounds like science fiction, but it's not. I've been saying this for years, and the science has now finally been done to prove it.

The Parrillo diet is specifically designed to channel nutrients to muscle and to draw on stored body fat as a fuel source. This amounts to using nutrition to direct the flow of dietary energy along certain biochemical pathways to achieve the effect of partitioning dietary energy into the lean compartment while simultaneously drawing on fat stores for energy. I think you can see that setting up this sort of hormonal and metabolic environment in the body is inherently more powerful than supplements could be when thrown in on top of a regular diet. Most people don't know how to use supplements and that's why they don't get good results. You have to have the diet in place to form the foundation. This converts the metabolism into muscle-building, fat-burning mode. Changing the metabolism is the first, most important, step. Then the supplements can do their job.

A question I get constantly is what are the most important supplements and which ones should I be using. Some people think they need to use them all to get results. Not true. For building muscle and gaining strength, the most important ones are Creatine and Hi-Protein Powder. This is a powerful combination. Just these two products alone can boost your growth into the stratosphere. Parrillo Hi-Protein Powder is a special formulation including a mixture of casein and whey protein with free form amino acids added to adjust the final amino acid profile to be optimal for muscular growth.

If you're an ectomorph (naturally skinny person) and want to gain pounds of body weight, use the combination of Pro-Carb and Hi-Protein. These supplements can add quality calories to your diet to help you pack on muscle. I've seen guys gain 20 to 30 pounds in six months on this combination. It doesn't take a complicated program to get results. It takes the right diet and the right supplement. For gaining weight what you need is calories. Keep the fat grams very low to avoid gaining body fat.

For fat loss the best product is CapTri. Be sure to watch your calories. CapTri is a very high calorie product, and if you just start pouring it on your regular food it will not make you lose weight. What you have to do is subtract a given number of calories of starchy carbs from your diet and replace those calories with CapTri. This lowers the energetic efficiency of your fuel mix, meaning that more dietary energy is converted to body heat. This loss of dietary energy as body heat means that those calories are not available to fuel activity, so your body is forced to draw more heavily on stored fat as a fuel source. This low-carb approach also reduces insulin levels which further promotes fat loss.

Endurance athletes should try Liver-Amino and Hi-Protein Powder. You might have thought Pro-Carb would be a better choice, but endurance athletes usually get plenty of carbs from their diet. The surprising truth is that many endurance athletes are protein deficient.

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These should give you some ideas to get you started. Whether you want to use supplements or not, be sure to stick to the diet. Often times when one of my long-time clients calls in with a problem, it turns out they've strayed away from the diet or else are having a hard time eating enough calories to support further growth. This is a perfect time to add in a supplement. We're always here to provide advise on your nutrition or supplementation program. Just give us a call.

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No Limits: How To Break Through Plateaus, Part I

by John Parrillo

A very common problem among bodybuilders, especially advanced bodybuilders, is hitting a plateau. What to do when you hit a plateau is one of the most frequently asked questions I receive. The answers are highly individualized depending on the specific problem, but I can give you some general guidelines to help you troubleshoot the difficulty. The main point is that if you're not making progress in your bodybuilding goals, then you're not doing what it takes to make you better. As obvious as that sounds, many people fail to realize this. A lot of people stick with the same program month after month, sometimes even for years, without seeing any real change in their physiques. They keep waiting for it to start working - for something to happen. A good rule of thumb is that you should see some improvement on at least a monthly basis. Take inventory of your progress at regular intervals, say at the beginning of every month. If you like what you see and you're making good progress, keep doing what you're doing. On the other hand, if a month goes by and you haven't made some noticeable improvement, it's time for a change. The biggest mistake you can make is to faithfully stick to a program that's not giving you good results.

These suggestions to "take inventory" and "look for improvement" lead directly to the second major concept, which is that you need to be scientific about analyzing your progress. You cannot achieve greatness in any field by guesswork, including bodybuilding. You need to have some specific, objective goals and keep records to determine if you're making progress toward achieving them. The basic goals for bodybuilders are to increase muscle mass, to decrease body fat, to increase strength in the basic lifts, and to improve overall size, shape and symmetry. To know if you are making progress toward increasing muscle mass or losing body fat, you need to periodically measure your body composition and keep records. To monitor your gains in strength, you need to keep a training journal and record your performance on basic lifts like squats, deadlifts, bench presses, shoulder presses, and rows. Set some specific goals, such as to gain a pound of muscle per week for the next 12 weeks, or to reach an all-time personal low body fat percentage, or to get a new personal best in the bench press. If you don't have specific goals, and if you don't monitor your progress toward reaching those goals, then it's hard to know if you're really making any progress or not. Most people in the gym don't ever bother to formulate specific goals, don't keep a training journal, and don't measure their body composition. They're the ones who lift the same weight month after month and whose bodies never change. One of the best ways to set a goal is to pick a date six to twelve weeks in the future and to plan for a certain body weight and fat percentage at that time. For example, "By next I want to weigh 220 pounds at 6% body fat. This means that by May I need to gain 10 pounds of muscle and lose 8 pounds of fat." This gives you some specific goals to shoot for, and a timetable to monitor your progress. Of course, you can't do it without measuring your body composition. The Parrillo Performance Body Stat Kit was made just for this reason, and includes a manual with detailed instructions on how to modify your program to keep making progress.

You cannot achieve greatness in any field by guesswork, including bodybuilding. You need to have some specific, objective goals and keep records to determine if you're marking progress toward achieving them.

Bodybuilding is not really all that complicated. If you're not making good progress you need to make some kind of a change, and the two places to makes these changes are in your training or your nutrition. Don't be afraid to change one or both of these. Let's consider the muscle gaining plateau first. The most common problem here is with nutrition - people just don't eat enough calories to sustain further muscle growth. Consider this: your body's daily energy expenditure - the number of calories you burn in a day - is determined by your muscle mass, among other factors (1,2). Muscle is metabolically active tissue - a pound of muscle requires 25-30 calories a day to maintain and up to 100 calories to build. This means that as your muscle mass increases your daily calorie requirement increases at the same time. As an example, let's consider a hypothetical 180 pound bodybuilder whose maintenance energy requirement is 2500 calories a day. This means that during an average day, his body burns 2500 calories total. If he consistently consumes less than 2500 calories a day he'll lose weight, and if he consistently consumes more than 2500 calories a day he'll gain weight. If he consumes 2500 calories a day, his present body weight will be maintained, and that's why we call this his "maintenance energy requirement." Now let's say he wants to pack on some mass, so he starts eating 2800 calories a day. For several weeks he will gain at about a pound a week, but then the gains stop. Why? Well, if each pound of new muscle burns 30 calories a day just for maintenance purposes, and he gained 10 pounds, that's 300 more calories he burns every day just to maintain his body. That means his new maintenance energy requirement is now 2800 calories a day, not 2500 like it used to be. So for awhile he was making good gains on 2800 calories, but the added muscle has increased his metabolic rate so that now he needs 2800 calories a day just to maintain his new weight. So the gains stop. To add the next 10 pounds of muscle he would have to increase calories again.

This is pretty basic stuff, but you'd be surprised how often it's overlooked. For many people, gaining more muscle is as simple as eating more calories. Many bodybuilders are afraid to try it because they're afraid they'll gain fat. The key is to eat clean, lean bodybuilding foods. The Parrillo Nutrition Manual describes how to increase your

calories from foods which are more prone to help you build muscle and which are difficult for your body to store as fat. What's the best way to increase calories to gain more muscle?

Generally speaking, an increase in complex carbohydrates is the best way to go. You also need to increase your protein intake as you gain weight, so that you're getting at least one to one-and-a-half grams or more of complete protein per pound of body weight each day, but the bulk of your calories should be derived from carbohydrates. By increasing your carbohydrate intake, this will increase your ratio of insulin to glucagon and increase the anabolic drive to build more muscle (3). Increasing your carbohydrate intake actually provides a more potent growth stimulus than increasing protein. Remember this as a general rule: as your body weight increases, increase your protein. As your energy requirement increases, increase your carbs. A growth plateau generally means you need more calories, not more protein (as long as you're meeting your one to one-and-a-half grams or more per pound per day requirement). And those calories are best supplied as carbohydrates. Be sure to use complex carbs and stay away from sugar or refined carbs, which are easily converted to fat.

A brief word on supplements here: provided your protein requirement is being satisfied, the most potent supplements for gaining weight are probably Pro-Carb Powder™ and CapTri®. A couple scoops of Pro-Carb® taken with or between meals will in itself be enough to help most people pack on several pounds of lean muscle. If you find that you're putting on fat, consider using CapTri® instead. It supplies calories in a way which is almost impossible for your body to convert to fat (4,5). And if you don't tolerate carbs too well, CapTri® can give you the added calories and help maintain a more favorable glucagon/insulin ratio.

As you continue to gain lean mass, your metabolic rate will increase, so you'll have to gradually increase your caloric intake to support further weight gain. It's not uncommon for big bodybuilders to eat 6,000 calories a day or more. Don't make the mistake of increasing calories too fast, however. You might be tempted to say that you want to gain 40 pounds, and try to do it all at once by upping your calories by several thousand. If you do that all at once, you'll gain a lot of fat along with the muscle. You can only build muscle so fast, and if you push your calories up too fast you'll get fat. On the Parrillo Performance Program, we recommend gaining at a rate of about a pound a week. That way, you know you're adding solid muscle mass, instead of possibly packing on fat. It's best to increase your calories in increments of 300-500 a day. Although it takes around 30 calories a day to maintain a pound of muscle, it takes much more to actually build that muscle. That's why you can't just add 30 extra calories a day and expect to gain a pound of muscle in a week. Just doesn't happen that way. And as your maintenance level changes, so will the number of calories you need. Your body just doesn't gain ten pounds on 300 to 500 extra calories then stop, waiting for that next 300-500 calorie increase. Your growth and caloric needs are constantly changing.

As you eat more you provide your body with the nutrients to gain more muscle, and as you gain more muscle, you'll need to increase your calories to maintain the muscle you've already gained plus the extra calories your body needs to make new muscle. That's why it's so important to record what you're eating on Diet Trac Sheets and check your body composition regularly using the BodyStat Kit. A lot of people think this tool is used only during the pre-contest period. But in actuality, the BodyStat Kit can tell you a lot about your lean mass and body fat and how these percentages change according to your diet and training.

The other possible problem if you hit a plateau could be in the area of training. Within this category, you could be undertraining, over-training, or not training intensely enough. Just as your nutritional needs change as you gain more muscle mass, you will find that periodic variation in your training will help you break through plateaus. Although it's hard to make generalizations about this, probably the most common mistake here is not training intensely enough. Intensity is the key to productive weight training exercise. Increasing or decreasing the volume of exercise you do won't make much difference if the exercise you're doing is not intense enough to stimulate muscle growth in the first place. The key principle here is progressive resis-

tance—you have to lift heavier weight if you want to get bigger and stronger. This is why keeping a training journal is so important. On a monthly basis you should be getting stronger on the basic lifts. Certainly now you should be benching, squatting, and pressing more weight than you were this time last year. If you're not, you need to make a change. Every workout you should try to lift a heavier weight than you did the last time, or else do more reps with the same weight. It may not be realistic for an advanced bodybuilder to increase the weight at every workout, but if a month or two goes by with no improvement, that's a sign it's time for a change.

What do you change? The variables to play with here are endless, but the bottom line is that you want to increase your strength on the basic lifts. This means lifting more weight on squats, bench press, shoulder press, rows, and deadlifts. Training for strength and training for size are not the same, but they do go together. The best way to train for strength is to lift very heavy weights in the 3-6 rep range and keep the volume fairly low. To train for muscle size it's better to do 8-12 repetitions and to do a higher volume of exercise. It's important to train to positive muscle failure, so that you can't perform another repetition. When training for size, it's also very important to emphasize the eccentric phase of the muscle contraction. That means you need to resist the weight as you lower it while the muscle is lengthening. When you can perform 12 repetitions in good form, it's time to increase the load. This is where many people fail in the gym. They do the same 3 sets of 10 reps with the same weight every week and never increase the load. They never get any stronger and their muscles don't grow. You have to continually push yourself. You have to continually challenge yourself with heavier weights.

Regarding the issue of whether you should train in the 3-6 rep range or the 8-12 rep range, I think you should do both. In last month's article I suggested a program where you do "powerlifting-style" training (3-6 rep range) for one month, then "bodybuilding-style" training (8-12 rep range) the next month. Alternatively you can do low reps one week and moderate reps the next week, or even incorporate both into each workout. Any of these approaches will work, just so you remember to try and increase the load or the number of reps as often as possible. I suggest making some alterations in your training program every 4-6 weeks to present your muscles with a fresh stimulus. Your muscles seem to adapt to a given training regimen after about a month.

Regarding the questions of specific training routines, training volume, and training frequency, I would have to write an entire book to cover these issues. (Actually, I wrote three books about that - The Parrillo Performance Training Manual, John Parrillo's Fifty Workout Secrets, and High Performance Bodybuilding.) What I can tell you here are just some basic concepts. Everyone seems to be searching for the "ultimate" workout routine, as if it were some sort of holy grail. The truth is, there is no single ultimate routine, although some are better than others. The key concepts are to emphasize the basic exercises, train hard, train to failure, continually lift heavier weight, and periodically alter your workout to get some variety. Many bodybuilders rotate their body parts five or six days a week, training only one muscle group at each workout. Others do better on a three or four day rotation and training two or three muscle groups at each workout. Experiment with a six day split, training six days a week, one body part per workout, versus a three day split, training two body parts per workout. See what works best for you. The only mistake you can make is to stick with a program that's not working. Check out my training books if you want more details on designing routines and on exercise performance.

When you can perform 12 repetitions in good form, it's time to increase the load. This is where many people fail in the gym. They do the same 3 sets of 10 reps with the same weight every week and never increase the load. They never get any stronger and their muscles don't grow.

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No Limits: How To Break Through Plateaus, Part II

by John Parrillo

In the first part of this series I discussed breaking plateaus in your muscular development. Most of the article dealt with nutritional considerations and how to manipulate and regulate your nutrients to spur muscle growth. At the very end I began to delve into adjustments in your training to spark lean mass gains should you reach a plateau. There are several more aspects concerning training and muscle gain that need to addressed before I move on to the second part of the discussion, breaking through fat-loss plateaus. So if you're ready, let's get started.

I get people who call all the time, looking for my "blessing" to take a couple of days off. "What about over-training?" they ask. "Should I cut down on training?" "Should I take a lay off?" Everybody these days is worried about over-training. I would like to respond to this on two levels. First, if you think you will stimulate your muscles to grow bigger by not training them, you're fooling yourself. It's the workout that stimulates your muscles to grow. Less workout means less stimulus. Rather than cutting back on your training, consider increasing your nutritional support instead. This is where supplements can really help - when you're training so hard that you can barely recover. Of course it is possible that you may fail to recover from your workouts, and in that sense you may be "over-trained." That doesn't mean that you're exercising too much however, it means that you're not recovering enough. This state of "over-training" really describes the state of your body's balance between stress (exercise) on one hand and recovery on the other. If the level of stress is so high that you're not recovering, the answer most people give is to train less. Rather than this imbalance being a problem of too much exercise, I view it as a problem of not enough recovery. People are not over-trained, they're under-recovered. Before you cut down on your training, beef up your nutrition and get more rest. Approach your nutrition with as much intensity as your workouts. Also, make sleep a priority. Eat right, eat a lot, get enough sleep, and you probably won't feel over-trained any more. What's the alternative? Train less and eat less. Does that sound like the way to get your body to grow?

> When it comes to over-training, I find that the volume of high intensity exercise is rarely the problem. The problem usually turns out to be a large volume of low intensity exercise. This is not an effective stimulus for growth but will contribute to fatigue.

Now I would like to respond to the question of over-training at a second level. This has to do with the volume of exercise versus the intensity of exercise. You cannot make up for low intensity exercise by increasing the volume. If you're lifting half-heartedly without giving it your full effort, then adding a few extra sets onto the end of your workout won't help. While these low intensity sets will not stimulate muscle growth, they will however use up your recovery ability. If you find your weight training sessions are dragging on for two or three hours and you're still not growing, I suspect your exercise volume is too high and your intensity is too low. When you enter the gym, you must be very serious and all business. You're not in there to socialize and have fun. Hit the weights hard at full intensity. Generally, you should be done with your workout in 60 minutes, and 90 at the most. When it comes to over-training, I find that the volume of high intensity exercise is rarely the problem. The problem usually turns out to be a large volume of low intensity exercise. This is not an effective stimulus for growth but will contribute to fatigue.

Another area often overlooked is aerobics. When discussing this issue, many people will say if you spend your energy on aerobics then that leaves you with less energy to grow. This is a rather short-sighted solution to the problem. Your muscles need nutrients to grow. They need blood flow. Moderate to high intensity aerobic exercise will increase capillary density and blood flow to muscles, providing for greater nutrient delivery (1,2). This will allow for more growth over the long term. I am convinced that if you include aerobic exercise in your training program this will allow for greater overall muscular development over the long term. You should obviously do more aerobics when preparing for a contest and less while you're trying to gain weight, but I believe you should do aerobics year round. Twenty to thirty minutes a day on the bike will burn 250-300 calories, so if you're trying to gain weight just eat a few more calories to make up for it. Think of it this way: in the off season eat a Parrillo Bar and ride the bike for at least 30 minutes. You'll strengthen your cardiovascular system, have a richer blood supply, and end up with bigger muscles. The other benefit of aerobics is that it helps you burn fat, so while you're gaining muscle you'll stay lean. Some bodybuilders are afraid to do aerobics in the off season because they think it will make them lose muscle. This won't happen if you simply eat enough calories to compensate for those used during the aerobic activity. If you eat enough high quality calories, this will support muscle growth while the aerobics helps you lose fat.

What about supplementation? Can this help me gain more muscle? Yes, but I want you to sort out the problems with your diet and training program first rather than hope that supplements will somehow fix everything else. Remember, the foundation of bodybuilding success is hard work, consistency, and dedication to a solid diet and training program. Supplements are the icing on the cake, not the foundation. If you're eating sloppy and training half-heartedly, supplements will not give you the results you're after. On the other hand, if you're eating right and training as hard as you can, supplements can improve your gains over what you could achieve without them.

The single best supplement for gaining muscle is Creatine. This is a molecule stored inside muscle cells and is involved in energy production (1,2,6,7). It increases muscle size and strength dramatically within the first month of using it. Muscle gains of 4-14 pounds and strength increases of 10-15% are typical during the first month of creatine supplementation. That's quite amazing when you think about it. Most of the muscular weight gain is do to storage of water inside muscle cells. As creatine is stored in the muscle, it attracts water, causing the

muscle cell to swell. The strength increases are due to increased energy producing ability of the muscle (1,2,6,7). While muscle gains during the first month of creatine supplementation are miraculous, things slow down after that. After the muscles are saturated with creatine they can't soak up anymore, and after that it's a matter of maintenance of creatine stores. For the first 1-3 weeks you should use 20 grams of creatine a day to fully load the muscle, then after that 5-10 grams a day is enough to maintain muscle stores. It stands to reason that muscle protein gain will ultimately be enhanced as well, leading to faster muscle growth, because you're able to train heavier while using creatine. This, of course, if providing you increase your protein and calories to support this growth.

The next most important supplements are ones which provide these calories and extra protein, since inadequate caloric and protein intake is the most common reason for failing to gain more muscle. The best choices are Hi-Protein Powder™, Pro-Carb™, and CapTri® which are specially formulated to minimize fat accumulation while increasing calories. A scoop of Pro-Carb™ and Hi-Protein™ mixed together in water has the perfect nutrient profile to support muscle growth. I'm working on a new combination product which will contain essentially this same nutrient breakdown. If you're prone to gaining fat whenever you increase calories, I suggest you use CapTri®. CapTri® is unique in that it is a way to provide more calories with virtually no tendency to be stored as fat (4,5). At the high end of the supplement ladder are the amino acids. Muscle Amino Formula™ supplies pure branched chain amino acids, the most common amino acids incorporated into muscle protein. This supplement is usually reserved for competitive bodybuilders and endurance athletes. It has the effect of making the muscle harder and fuller and is especially useful to minimize muscle loss while dieting for a contest. If you're training hard and long enough to lose your pump by the end of your workout, this is a tremendous supplement for you. Liver-Amino Formula™ is also a great supplement because it contains 1½ grams of protein per tablet as well as heme iron. Take five to eight with each of your six meals, you're looking at an additional 45

By losing muscle mass your body can decrease its metabolic rate, or the number of calories it requires to survive each day. This means the fat stores will last longer, since with less muscle the body requires fewer calories to maintain itself each day. So during severe caloric restriction you lose muscle and your metabolic rate decreases. And with a slower metabolism, the rate of fat burning slows down.

to 72 grams of protein. For additional calories, the Parrillo Bar is a tremendous addition to your diet. It contains 250 calories per bar, which includes 11 grams of quality protein, 37 grams of complex carbohydrates and five grams of CapTri®.

You should now have a pretty good idea of the areas you should concentrate your focus on if your goal is to pack on lean mass. Now I want to share some tips on what to do when your progress stalls when you're dieting to lose fat. Of course, gaining and losing are contradictory by nature. What you'll find, however, is that the goals in bodybuilding and fitness dictate that you do both at the same time. It's a crazy thought, but it's possible. Want to know how. Read on.

When you talk to most people about fat loss, the most obvious way they'll say to lose weight is to restrict calories. And in fact, the fastest way to lose weight is to stop eating altogether. Unfortunately, when you lose weight by severe caloric restriction about half of the weight you lose is muscle. This is known as "the starvation response." When you severely restrict food intake your body thinks it's starving (which it is) so it makes certain metabolic adaptations to allow it to survive longer without food. Your body fat represents stored energy for just such an emergency, so your body tries to make it last as long as possible. During starvation your metabolism shifts and you end up losing as much muscle as fat. Recall pictures you have seen of prisoner of war survivors or famine survivors. True, they have no body fat, but they have no muscle mass either. By losing muscle mass your body can decrease its metabolic rate, or the number of calories it requires to survive each day. This means the fat stores will last longer, since with less muscle the body requires fewer calories to maintain itself each day. So during severe caloric restriction you lose muscle and your metabolic rate decreases. And with a slower metabolism, the rate of fat burning slows down. All of this makes great sense from the point of view of surviving a famine, but it's exactly the opposite of what bodybuilders want to achieve.

Bodybuilders don't want to lose any muscle while they lose fat. Furthermore, we don't want to slow down our metabolic rate because that would mean slower fat loss. So how do we do it? The key is to continue to feed your body the nutrients and calories it needs to maintain its muscle mass, and to draw on stored body fat as a source of energy. Resist the temptation to cut calories or skip meals. That's the worst thing you can do. But before we deal with the specifics, we need to lay some groundwork. Some of the basic issues are: How many calories should I eat? Don't I need to cut calories? How fast can I lose fat? What can I do to make sure I'm not losing muscle?

In order to lose weight you have to burn more calories than you eat. This is called a negative energy (calorie) balance. You can do this by either eating fewer calories or by burning more calories.

Many times in previous articles I've referred to a concept called your "maintenance energy requirement." This is the number of calories you need to consume per day to support your present body weight and activity level. Metabolically speaking, this is known as your total energy expenditure, or TEE. It is the sum of your basal metabolic rate (the amount of energy your body expends while at rest, such as during sleep) plus the energy you expend during activity, including exercise, plus the thermic effect of feeding plus another factor called adaptive thermogenesis. There are several ways that research scientists who study metabolism have of figuring this out. One way is to have a person live in a special chamber called a calorimeter and measure the heat given off by the body. This technique is referred to as "direct calorimetry." Another way is called "indirect calorimetry" and involves measuring the amount of oxygen consumed by the body and the amount of carbon dioxide produced and using this data to calculate the amount of calories expended. These are obviously expensive research procedures and are not available to people who just would like to know what their TEE is. You have an easy way of figuring this out for yourself, however, and it doesn't cost anything. Simply weigh all your food and record everything you eat for a week sometime while your weight remains constant. Pick a week when you're doing your normal workout and your normal amount of aerobic activity. Calculate the average number of calories you consume a day during this period and this is your maintenance energy requirement (MER). Most bodybuilders on the Parrillo Nutrition Program weigh their food and record their calories anyway, so it doesn't take any extra work. Just look over your Diet Trac Sheets from a week when you didn't gain or lose any weight and calculate the daily average. If you haven't done this yet, you need to. It provides a scientific basis for making many decisions about your diet. I can't tell you how many calories to consume until you know this number. The concept of the MER also provides a useful way to teach you how to construct and adjust your diet.

After you determine your MER, we can talk about calories. If you want to maintain your present body weight, you need to consume the number of calories equal to your MER - this is simply the definition of MER. If you want to gain weight, you need to consume about 300 to 500 calories per day more than your MER. This will result is a positive energy balance, which means that you are consuming more energy (calories) per day than you are expending. These extra calories can be stored as body weight. If you're eating right and training hard, most of it will be muscle. If you want to lose weight, you need to achieve a negative energy balance. This means that you need to expend more calories per day than you consume.

There are two ways we could go about this. First, we could consume less calories than our MER, meaning that we're eating fewer calories than our body needs to maintain itself. This will result in weight loss, but as we discussed previously, anytime we reduce calories we run a risk of losing some muscle. Alternatively, another way of bringing about a negative energy balance is to increase our energy expenditure. By doing more aerobic exercise you can increase your TEE and achieve a negative energy balance while still consuming your MER. This means enough calories and nutrients will be provided to maintain your present muscle mass as you lose fat. Whereas the weight lost by caloric restriction can be as much as 50% muscle, the weight lost by increasing aerobic exercise activity while maintaining constant calorie intake is almost entirely fat (7,8).

To summarize, in order to lose weight you have to burn more calories than you eat. This is called a negative energy (calorie) balance. You can do this by either eating fewer calories or by burning more calories. The approach I recommend is to eat the number of calories equal to your MER and to increase the amount of calories you burn by doing more aerobics. This will result in more efficient fat loss and less muscle tissue loss than the approach of cutting calories. You still provide ample calories and nutrients to maintain your muscle but draw on stored body fat to fuel your aerobic exercise. Furthermore, aerobic exercise builds the metabolic pathways that burn fat (1,2). It increases the mitochondria and enzyme pathways that metabolize fat. And by NOT cutting calories, your body will not decrease its metabolic rate and enter into the starvation mode. Not only is this strategy logical, but it is backed up by the scientific literature. More importantly, it is backed up by the real life experience of thousands of bodybuilders. It's just the way that works best.

Now keep in mind we're talking about your MER here. If you just finished a weight gaining cycle you probably were consuming 300-500 calories in excess of your MER in order to pack on some mass. So you may in fact want to decrease calories from what you had been consuming to gain weight, but don't decrease them below your MER. This is why it's important to have some idea what your MER is. This is a useful baseline number that allows you to make some rational adjustments instead of just guessing. Also keep in mind that as you increase muscle mass your MER will increase as well. Muscle is metabolically active tissue and requires energy and nutrients to support. For every 10 pounds of muscle you gain you will have to eat about 300 more calories a day (roughly) just to maintain your new body weight. So don't forget to keep checking your MER periodically and make adjustments. If you keep a nutrition log and Diet Trac Sheets like you're supposed to, it will be easy. So when I say not to cut calories to lose weight, what this literally means is don't reduce calories below your MER, the level you need to maintain your present muscle mass. If you've just been in a calorie-excess mode, then reducing calories to your MER is reasonable.

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No Limits: How To Break Through Plateaus, Part III

by John Parrillo

So far this series has addressed ways to help you break through plateaus in your muscular development as well as how to spark fat-burning when you've seem to have reached a plateau. This month I'd like to finish up on how to continue fat loss.

So far we've covered the most basic concepts of fat loss: eat right and stay strict on your diet (I'm not even going to elaborate on that in this article—we've been through it several times lately), don't cut calories below your MER (maintenance energy requirement), and use extra aerobics to burn body fat. A couple more items of groundwork need to be addressed. How fast should you lose fat? A pound a week is a good general rule. It is possible to lose fat faster than that, but you increase your risk of losing muscle if you do. I have found most people can lose one pound of fat per week without losing much muscle. So plan ahead. If you want to lose 20 pounds of fat plan on 10 weeks of dieting, a two-week break to build your metabolism, and 10 more weeks or dieting, for a total of 22 weeks. If you want to enter a contest, plan on being ready two weeks out, so you have time to fine tune things and fill out a little at the end. Keep in mind that when I say "diet" you still get to consume a lot of calories—your MER. This is not a painful starvation diet.

A pound of fat contains approximately 3,500 calories, so to lose a pound a week that means you need to achieve a negative energy balance of 500 calories a day (multiply that by seven days a week and you get 3,500 calories). Do this by consuming your MER and doing 500 calories worth of extra aerobics a day beyond what you normally do. This could be anywhere from 30 to 60 minutes of extra aerobics a day, depending on how intense your aerobic activity is. When you do your aerobic exercise you should be breathing hard and sweating. This is a more reliable sign that you're burning fat than your heart rate.

How do I know that I'm losing fat and not muscle? By using the Body Stat Kit once a week. You can determine your pounds of lean mass and pounds of fat every week and make adjustments in your training and diet accordingly to make sure you stay on track. The Body Stat Kit Manual contains detailed instructions on exactly how to change your training and diet to make sure your body composition keeps moving in the right direction. I think one of the reasons the Parrillo Program has been so successful for so many people is that everything is scientifically controlled. How many calories, how much protein, carbs, and fat, how many meals, which foods, how to combine the foods, macronutrient ratios, Diet Trac Sheets, the Training Log, Body Stat Sheets—it's all in the manuals. Every parameter of your bodybuilding program is covered and nothing is left to chance. If you weigh your food and keep track of your diet and body composition like you're supposed to, and something's not working right, we can pinpoint exactly what the problem is and make detailed adjustments to fix it. Otherwise, if you're just going on what "feels right" or seems to make sense, and you don't make good progress, you're not sure what to change.

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A very successful approach I wrote about a couple of months ago involves alternating one month on a weight gain cycle with one month on a fat loss cycle. This way your metabolism never adapts and you avoid the problem of plateaus altogether. Let's say one month you gain a pound a week (four pounds) and it's 75% muscle. That's three pounds of muscle and one pound of fat. The next month you lose a pound a week and it's 75% fat. So that month you lose three pounds of fat and one pound of muscle. At the end of the two month cycle the net result is that you've gained two pounds of muscle and lost two pounds of fat. After one year you would gain 12 pounds of muscle and lose 12 pounds of fat. I believe these goals are quite realistic and very easily attainable for anyone, and particularly easy for bodybuilders who are giving 100% effort to the training and nutrition program. The beauty of this idea is that you're constantly making progress, you're always either gaining muscle or losing fat, and the constant change prevents your metabolism from adapting so you can make continual progress without wasting time being stuck on a plateau and trying to figure out what to do. In principle you could keep this up for year after year. If you're 20% body fat or more, you may want to devote a few months to getting in shape first, or if you're really skinny you may want to spend a few months just putting on size. But if you're somewhere in the middle, maybe around 10% body fat, you might consider giving this program a try. To gain a pound a week increase your calories to 300-500 above your MER, do 20-30 minutes of aerobics a day, and train like a powerlifter with heavy sets in the 3-6 rep range. To lose a pound a week decrease calories to your MER, do 60 minutes of aerobics a day, and train like a bodybuilder with increased volume and moderate weight in the 8-12 rep range. I think this approach may well work better for today's leaner, cleaner natural bodybuilder than the old style of weight cycling, which often involved gaining 50 pounds in the off season, then losing 40 pounds during the pre-contest diet to come into the show 10 pounds heavier than last year. (Although this method also had its pluses, like stretching the fascia.)

Now let's move on to some specifics. So we don't want to cut calories, because that can easily lead to muscle loss. Are there any other dietary manipulations that can help? Yes. Continue to eat five, six or more meals spaced evenly throughout the day. This has several beneficial effects. Every time you eat your metabolic rate increases a little due to the thermic effect of feeding (also known as diet-induced thermogenesis). Eating frequently keeps the furnace stoked and keeps your metabolism speeding along. If you go too long without eating your metabolism begins to slow down. Make every effort to eliminate fat from your diet. I won't go into the details here, but dietary protein and complex carbohydrates have negligible tendency to be converted to fat, whereas dietary fat is very prone to be stored as body fat (1,2,3,4). This is a hot topic in the scientific literature these days and is a matter of debate in the bodybuilding magazines. (It is less a matter of debate in the scientific journals, where actual research is reported.) Very little of your body fat comes from complex carbohydrates or protein being converted into fat; almost all of it comes from fat you eat. How much fat your body stores seems to be more closely related to how much fat you eat rather than how many calories you eat. Admittedly, this is less important during calorie restricted diets. During low calorie diets you are not eating enough calories to maintain your body weight, so all of the calories you eat will be burned, even if some do come from fat. However, in diets which provide enough calories to maintain body weight or even enough to support growth (including the Parrillo Diet) then the fat content becomes very, very important. If you eat a weight maintenance diet or an energy surplus diet to support growth, then the calories supplied as dietary fat will be stored as body fat, not muscle. Part of the confusion in the bodybuilding magazines is due to the failure to distinguish the various experimental designs and improperly applying this information to bodybuilding.

Without restricting calories, there are some things we can do to help shift the metabolism into fat-burning mode. First is to eliminate fat from your diet. Whenever you do aerobics some of the fuel is derived from carbohydrates and some from fat. If you're not eating any fat or simple sugars which are easily turned into fat, then the fat you burn during aerobic exercise must come from stored body fat. If dietary carbs and protein are not converted to fat (and they're not under conditions of a diet supplying a number of calories equivalent to the MER) then you will achieve negative fat balance. This means that on a daily basis your body burns more fat than you eat, so you lose body fat. Metabolically speaking, this means your respiratory quotient is less than your fuel quotient. Within the last few years it has been discovered that this condition (RQ less than FQ) must be satisfied for fat loss to occur. What this means is that to lose fat you have to achieve a negative fat balance, not a negative energy balance as is commonly thought. In simple terms: dietary fat matters more than calories. To lose fat, don't eat any fat and do aerobics to burn stored body fat. It's that simple. We've been doing it that way at Parrillo for years, but the exact details of how it works are just now coming out in the scientific journal articles.

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Second, decrease your carbohydrate intake. This lowers insulin levels and promotes fat burning. How do you cut down on carbs without decreasing calories? Well, you have to eat more of something else. Fat is not an option, so your only other choices are protein or CapTri®. Either one will work, but a combination of both probably works best. Let's be brutally honest about this. If you're used to getting most of your calories from carbs, cutting back significantly on carbs makes you feel bad, at least for a while. People who cut their carbs dramatically have low energy levels, are irritable and grouchy, and get headaches. Low carbs sucks, basically. You'll get used to it after a while, but the first few weeks of a low carb diet are not fun. CapTri® is more effective at relieving some of these symptoms than protein because it's more readily used as an energy source. Protein is not a very efficient energy source. It's role is to serve as building blocks for repair and maintenance of tissues, not to provide metabolizable fuel. Using protein for energy is kind of like trying to burn a wet log. Carbs, on the other hand, are a great energy source. So if you want to reduce carbs in your diet to manipulate hormone levels and promote fat metabolism it makes sense to replace those calories with another fuel source, namely CapTri®. CapTri® is a good choice because it is readily burned as fuel and won't be stored as body fat, (5, 6). I suggest you ease into this slowly. Start by eliminating starchy carbs from your last meals of the day. Replace those lost calories from carbs with an equivalent number of calories from CapTri®. CapTri® actually has a higher thermogenic effect than carbohydrate, meaning that more of this dietary energy will be lost as body heat with less energy available for storage. This further promotes additional fat loss. Continue in this way until you reduce your daily carbohydrate grams to about half of what you normally consume. At this point you'll be eating mostly protein, vegetables and CapTri®.

Recently I did a feature on how to optimize your training to maximize fat loss. One of the most important points is to do your aerobics when you are relatively carb-depleted. This will cause you to burn more fat during your workout (because less carbs are available). The best time is first thing in the morning before breakfast. Your glycogen stores are the lowest they'll be all day, so you'll rely more heavily on stored fat. Take two scoops of Hi-Protein Powder™ to prevent muscle loss, then do your aerobics. Another good time is right after weight training, because then you're relatively glycogen depleted too. You should do moderate to fairly high intensity aerobics, so that you're breathing hard and sweating. While it's true you burn a higher percentage of calories from fat during low intensity aerobics, you will burn more grams of body fat if you perform high intensity aerobics, because you'll burn so many more total calories. Also, if you do reasonably intense aerobics you will get the added benefits of increased vascular density and enhanced fat burning capacity. Increase the volume of aerobics progressively as you get leaner. If your fat loss plateaus the first thing to try is to do more aerobics. If that doesn't work you should probably back off for a couple weeks, increase your calories, put on some muscle, and get your metabolism going again.

If you want more details than I have been able to squeeze into this article, check out the Parrillo Performance Nutrition Manual and the Body Stat Kit. I go into great detail about which foods to eat, which foods to avoid, and how to structure your meals. The Nutrition Manual contains a three step protocol for reducing body fat levels to contest condition, as well as describing how to manipulate carbs and water at the end. The Body Stat Kit contains instructions on exactly how to modify your training and nutrition program based on your weekly changes in body composition. The Nutrition Manual comes with its own food scale and Diet Trac Sheets to record your calories and grams of protein, carbs, and fat. It even includes a food composition guide that lists the nutrient breakdown of all the bodybuilding foods. The Body Stat Kit includes high quality calipers and everything you need to chart your body composition. Remove the guesswork from your bodybuilding program. Don't leave anything to chance. We've got all the details covered. You want results? Get them with Parrillo.

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Carbohydrates—The Optimal Fuel For Success, Part I

by John Parrillo

Recently we talked about the benefits of a high carbohydrate diet as compared to the high fat diet in terms of getting lean. Not all calories are created equal. Dietary fat is preferentially stored as body fat, whereas carbohydrates do not significantly contribute to fat stores (1,2,3). Most of your body fat is derived from the fat you eat and very little comes from conversion of protein or carbohydrate into fat (1,2,3). So it makes sense that if you want to reduce body fat the first place to start is to eat less fat. Proponents of the high fat diet say that carbohydrates cause insulin release which in turn stimulates fat storage. On the Parrillo diet we teach you how to select carbohydrate sources and structure your meals so that carbohydrates are released into the bloodstream very slowly, so this isn't a problem. To look at the big picture, if you consume too many calories from any source for a prolonged period of time some of these calories will end up as body fat. Conversely, if you operate in a calorie deficit for a prolonged period of time you will lose some fat. However, the results you will get in either of these situations are different depending on if you supply the bulk of those calories in the form of fat or carbohydrate. We have found that if you eat a diet higher in carbs and low in fat you will end up being leaner and more muscular whether you are using the diet to gain weight or lose weight.

This month I want to talk about the other half of the story, that carbohydrates are a superior fuel for exercise performance compared to fat. Not only will carbs make you leaner, they'll also give you more energy, strength, and endurance. We'll start with a review of energy substrate utilization during exercise, and then talk about dietary strategies to maximize your exercise performance. This discussion will apply equally well to bodybuilders and endurance athletes.

> Not all calories are created equal. Dietary fat is preferentially stored as body fat, whereas carbohydrates do not significantly contribute to fat stores (1,2,3). Most of your body fat is derived from the fat you eat and very little comes from conversion of protein or carbohydrate into fat (1,2,3). So it makes sense that if you want to reduce body fat the first place to start is to eat less fat.

Adenosine triphosphate (ATP) is the molecule that directly provides energy for your muscles. Before any foods can be used to fuel exercise, the energy they contain must be converted into ATP. When ATP is broken down it forms adenosine diphosphate (ADP) and free phosphate. To do this a phosphate bond is broken. When this happens energy is released and it is this energy which powers muscular contractions. You know that when you burn wood in your fireplace heat is released. Heat is a form of energy. When food is burned inside your body the energy which is released is used to manufacture ATP. The ATP is then broken down releasing that energy which it captured from the food, and this energy is the fuel your body uses at the cellular level to do its work, including muscular contractions.

The amount of ATP stored inside your cells is very small. Muscle cells contain enough ATP to power a maximal contraction for about two to four seconds (4). So the ATP has to be continually replenished as it is used. There are three energy systems in place for making new ATP so you can continue to exercise beyond four seconds. These are the phosphagen system, the lactic acid system, and the aerobic system. The phosphagen system is comprised of the "high energy phosphate compounds," which include ATP and creatine phosphate (CP). This is by far the fastest energy system and can provide for rapid bursts of high intensity exercise such as weight lifting, sprinting, football, and some track and field events. Muscle cells contain from three to five times more CP than ATP, and the phosphagen system can sustain maximal exercise for about six to eight seconds. After that, the CP is also used up and we have to activate another energy system. You can see why creatine is such an effective and popular sports supplement. It helps to provide more immediate energy allowing for higher intensity exercise. This is why creatine increases strength in weight lifters. As a nice "side effect" it also attracts water into the cell, making the muscles fuller and harder.

The next energy system is the lactic acid pathway. This can provide maximal energy for periods lasting up to one-and-a-half or two minutes. This pathway consists of the anaerobic conversion of glucose into lactic acid (anaerobic means "without oxygen"). This is actually a relatively long and complicated process involving several steps, and the overall pathway is called "glycolysis." The end result is that one glucose molecule is broken down to form two lactic acid molecules, releasing energy in the process. This energy is used to form ATP. Where does this glucose come from? By far the most important source of glucose for this process is stored muscle glycogen (4,5). Let's think about that for a minute. How long do most of your sets last in the gym? I'm not talking about the rest period, but the amount of time you're actually lifting weight with the muscle under tension. Probably anywhere from 30-60 seconds, generally. This is definitely longer than the phosphagen system can hold out without being replenished from some other energy source. Without calling in reinforcements, the phosphagen system by itself could only get you through the first rep or two. So what this means is that for very intense (maximal or near maximal) exercise lasting about a minute or so, such as weight lifting, the lactic acid system is the primary energy-producing pathway at work (4,5,6). And the primary fuel substrate for the lactic acid system is stored muscle glycogen (4,5,6). When you do a set in the gym most of the energy comes from stored muscle glycogen. So muscle glycogen is the most important fuel source for weight lifters, sprinters, football players, and other athletes performing short bursts of maximal exercise. A high carbohydrate diet is best for athletes because it helps maintain a high level of stored glycogen in muscle.

The problem with fat as an energy source for resistance exercise is that fat cannot be converted into glucose or glycogen, at least in humans. So a high fat diet cannot maintain muscle glycogen and therefore cannot support as high a level of exercise performance. You might wonder how people on extremely low carb diets can manage to lift weights at all. While fat cannot be converted into glucose, amino acids from protein breakdown can. So even if you don't eat any carbs at all you can still get a little muscle glycogen from breakdown of protein and conversion of amino acids into glucose. Also, the high fat diet results in the production of ketones which can be used by muscles as fuel for weight lifting. I suspect that most people who follow the high fat diets have extremely low muscle glycogen levels and in fact are able to perform some degree of resistance training using ketones as fuel. We have seen that when CapTri is used as an energy supplement during low carb "cutting" diets this greatly improves the ability to continue lifting. And we know that CapTri works by being converted into ketones by the liver. So I suspect the same process is going on with the high fat diets, except that it doesn't work nearly as well with conventional fats as it does with CapTri because CapTri is converted into ketones much more rapidly and completely than are conventional fats. On the Parrillo Program even when we use CapTri in this way, the bodybuilder is still eating some carbs, just not as much as usual. So he still has a significant store of muscle glycogen. The problem with the high fat diet is not only

that you have virtually no muscle glycogen, but also that the ketones which are available are not stored to any appreciable extent in muscle cells. So on low carb diets you have no muscle glycogen, meaning that you've knocked out the primary energy pathway used in weight lifting-type exercise. You do have ketones, but these can't be stored inside the muscle. You have less strength, less endurance, and since glycogen stores are depleted your muscles are flat and you have no pump. Not a very good way to go. There can be no doubt that carbohydrates are a much better fuel source for bodybuilders and endurance athletes than fat, and this is backed up by biochemistry, by the scientific literature, and by our own testing here at Parrillo Performance.

The third energy pathway is the aerobic system. This system can provide energy continuously for hours, but at a lower level of intensity compared to the other pathways. This pathway can use both carbohydrate and fat, and in fact is the only energy system that can use fat as a fuel substrate. As explained above, very brief and intense exercise such as weight lifting and sprinting is fueled by the lactic acid system (an anaerobic energy-producing pathway) and very long, low intensity exercise such as walking is fueled by the aerobic system. Moderate intensity exercise such as jogging or biking is fueled by a combination of both pathways. When the energy requirement demanded by the exercise does not exceed the ability of the aerobic system to supply ATP, then this is the primary energy system. A leisure walk is powered by the aerobic pathway, and you can sustain this level of activity for hours. If you pick up the pace and start jogging at a comfortable pace you can maintain for some time, this is still fueled by the aerobic pathway. If now you begin running fast, the aerobic energy system can no longer supply enough ATP to meet the energy requirement of your muscles and the lactic acid system kicks in. You can keep up this pace for several minutes - longer than the 2 minutes the lactic acid system could last by itself because it is being supplemented by the aerobic system. Now if we move up one more notch of intensity, such as weight lifting or an all-out sprint, the lactic acid system is operating at full bore and when muscle glycogen becomes depleted (among other factors) the exercise will stop. The aerobic system simply cannot supply energy fast enough to keep up with the demands of the muscle.

Now let's discuss how your body selects energy substrates during exercise. After we understand the patterns of energy substrate utilization we can design

be broken down so that the amino acids can be converted to glucose and used as fuel. Adequate glycogen availability "spares" amino acids, meaning that if your body has carbs available to use as fuel it won't need to use any protein. The next thing you can do is to use a scoop of Hi-Protein Powder right before your aerobics so that if any amino acids are going to be used as fuel they will be derived from the protein powder instead of your muscles. The Hi-Protein is probably superior to regular food for this purpose since it is digested rapidly and the aminos are released into the bloodstream faster than from whole, solid protein foods. I recommend doing your aerobics first thing in the morning before breakfast, because it's at that time that blood sugar levels are low and muscle glycogen is at the lowest level it will be throughout the day. This

effective dietary strategies to maximize our results. Glucose stored as glycogen in muscle and liver, and fatty acids stored as triacylglycerols (fat molecules) in adipose depots, are both important fuel sources for exercise. Factors which determine the balance between carbohydrate versus fat which is used as fuel include the intensity of exercise, the duration of exercise, the athlete's level of conditioning, and initial glycogen levels (4). Amino acids can also be oxidized (burned) to provide fuel, but normally contribute less than 10% of the energy cost of exercise. On the Parrillo Program we do everything possible to prevent the use of amino acids as fuel, because we want to maximize muscle mass. So for people on our program the contribution of amino acids to the fuel mix is even less than 10%.

By far the most important thing you can do to prevent use of protein as fuel is to make sure your muscle glycogen stores are always "topped off." That's another serious draw-back of the very low carb diets. Glycogen levels are so low the muscle protein is very vulnerable to

results in greater use of stored body fat as a fuel source during your aerobics since less carbohydrate energy is available. This does however put you at some risk for breaking down muscle, so that's why it's a good idea to have a serving of Hi-Protein Powder before your morning aerobics. Keep in mind however that this condition of relative glycogen depletion I'm talking about is a far cry from the near-zero levels resulting from low carb diets. Even first thing out of bed before breakfast, Parrillo bodybuilders have a lot of glycogen on board. This just turns out to be the time which it will be lowest during the day, so it's the best time to burn fat. So, if we control things such that we use very little or no protein as fuel, the energy cost of our exercise is supplied by a mixture of carbohydrate and fat. The relative contribution of carbohydrate and fat to the substrate mix being oxidized can be determined by measuring the respiratory quotient (RQ). This gets a little technical here, so I'll be brief. Carbohydrate molecules such as glucose contain oxygen, so the carbon atoms in the carbohydrate molecule are already partially oxidized. However, the carbon atoms in a fatty acid molecule are not partially oxidized. Therefore, when fat and carbohydrate are burned (oxidized) separately different amounts of oxygen are consumed per amount of carbon dioxide produced. So if we measure the amount of oxygen consumed and carbon dioxide produced by an athlete while he's exercising, we can "back calculate" if he's burning fat or carbs as fuel. (I hope that wasn't too painful.) An RQ of 1.0 indicates that essentially pure carbs are being used as fuel, and an RQ of 0.7 indicates that fat is the fuel source. Intermediate values of RQ demonstrate that a mixture of carbohydrate and fat is serving as the fuel supply.

What experiments like this have proven is that during very low intensity exercise (like walking) fat is the predominant fuel source (4,5,6). During sleep or rest almost exclusively fat is used. So if you believe these guys who advocate low intensity aerobics because it uses a higher percentage of calories from fat, then just sitting around and watching TV should get you ripped. As the intensity of exercise increases, we see that more carbohydrate is used as fuel (4,5,6). This progression continues until exercise intensity reaches V02max, at which time carbohydrate becomes the sole energy substrate (4). You will recall that V02max (vee-oh-two-max) represents the maximal rate of oxygen consumption by an athlete. This means that the aerobic energy system is completely maximized, and any further increase in energy needs must be met by the anaerobic (lactic acid) system. Since fat cannot be used by the lactic acid system, the energy at this point can only be supplied by carbs. This all makes good sense. We know that we can maintain low intensity exercise for prolonged periods of time (you could walk all day if you wanted to). That's because this activity is powered by the aerobic energy pathway, which can use fat as a fuel source. Your body has many more calories stored as fat than it can store as glycogen, because fat is a much more compact way to store energy and because you have limited space to store glycogen. You can carry on this low level of activity indefinitely because you won't run out of fat. But we can only sustain maximal exercise for a relatively short time, because this relies on the lactic acid system which can only use glucose as fuel (other factors contributing to muscle fatigue are also at play here). After the glucose (stored as glycogen) is used up the fat can't burn fast enough to meet the demands of the exercise. At very high exercise intensity oxygen cannot be delivered to the muscle fast enough to allow the aerobic energy system to operate, so the muscle must rely on the anaerobic (lactic acid) system, which can only use carbohydrate. The bottom line: fat cannot serve as the fuel source for very high exercise intensity, because it cannot undergo anaerobic metabolism. Carbs are the only fuel that can support maximal exercise intensity.

As you would expect, moderate intensity exercise uses a mixture of carbs and fat. As the duration of exercise proceeds, muscle glycogen gradually becomes depleted so oxidation of fat begins to make a greater contribution. We also see greater uptake of glucose from the bloodstream. This is attributable to greater muscle blood flow during exercise as well as more efficient extraction of glucose from the blood by the muscle. After 20 minutes of exercise muscle glycogen stores become partially depleted and the use of muscle glycogen slows (4). This is accompanied by increased use of blood glucose. The liver acts to help maintain blood glucose levels by breaking down its glycogen stores and releasing glucose units into the bloodstream. After both muscle and liver glycogen stores are depleted, which takes about two or three hours of moderate intensity exercise (marathon running or long distance cycling for example), is when we really get in trouble. At this point one of three things must happen: the exercise must be stopped or significantly reduced in intensity, blood glucose must be maintained by carbohydrate ingestion during exercise, or muscle tissue will be destroyed to supply amino acids as fuel.

It is well known that aerobic training allows one to perform "more aerobically" at the same absolute level of exercise intensity (4,7). This means that as your level of cardiovascular conditioning improves you can derive more and more of the required energy from fat and rely less and less on carbohydrates. This happens because cardiovascular training increases the number of mitochondria in muscle cells and the level of fat-metabolizing enzymes (4,7). In other words, the cellular fat-burning machinery is built up and your muscle learns to use less carbs and more fat. This is a great benefit of regular aerobic exercise. However, it won't happen if all you do is walk. In our experience here at Parrillo we have seen that there is an intensity threshold required to elicit this metabolic adaptation. You can't get your muscles to grow unless you lift intensely, and you can't train your muscles to rely more heavily on fat unless you do your aerobics intensely. Intense aerobics will have a much more marked effect in helping you get lean than mall walking. Trust me on this one.

An added benefit here is that as you train your muscles to use a higher proportion of fat in the substrate mix, this spares muscle glycogen. If you can burn more fat you don't need to burn as much glycogen. So you'll have more endurance plus greater strength as your workout proceeds. Depletion of muscle glycogen is associated with exercise fatigue (4). The glycogen-sparing effect resulting from increased lipid oxidation appears to be an important mechanism explaining why aerobic exercise causes an increase in endurance capacity (4). Furthermore, aerobically trained individuals seem to store more fat inside their muscle cells, as well as increasing their ability for intramuscular glycogen accumulation (4). You want to get lean? You want to get pumped? You want to maximize your strength and endurance? Do your aerobics and eat a high carb - low fat diet. You'll be amazed at the results. Next month we'll continue our discussion of carbohydrates and exercise and talk about dietary manipulation of fuel stores and energy substrates. What kind of carbs are best? When? How much? Stay tuned.

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Carbohydrates—The Optimal Fuel For Success, Part II

by John Parrillo

In the last article we began our discussion of carbohydrates as the preferred fuel for athletic performance. It is well known that the ability to sustain moderate to heavy exercise for prolonged periods of time is related to initial muscle glycogen concentration (1). The more glycogen you have stored in your muscles, the longer you can exercise at a given work load. One experiment showed that when muscle glycogen levels were 0.63 grams of glycogen per 100 grams of muscle, a standard exercise load could be maintained for 57 minutes before fatigue. When glycogen levels were increased to 1.75 grams per 100 grams of muscle, the same exercise could be performed for 114 minutes. And if the initial glycogen level was 3.31 grams per 100 grams of muscle the exercise could be continued for 167 minutes (1,2). The close correlation between muscle glycogen levels and time to exhaustion is a good reason to follow a high carbohydrate diet. It has been suggested that glucose and fatty acids cannot cross the cell membrane (that is, enter the cell) fast enough to provide adequate fuel for intense exercise (1). This is why muscle glycogen (glycogen already stored inside muscle cells) is the most important fuel for exercise.

Now let's talk about some specific dietary strategies to maximize endurance performance. It is very important to fill glycogen stores completely before participating in an exhaustive endurance event. Endurance athletes who train on successive days are likely to require 65-75% of their calories from carbohydrates to optimize performance (1). It may be that feelings of tiredness which are attributed to overtraining are in fact due to low glycogen stores (1). Some cases of "overtraining" may really just be under-nutrition. Foods rich in complex carbohydrates are preferable to refined sugars because they are more nutrient dense and result in lower blood glucose and insulin levels. This makes it more likely that the carbohydrate will be stored as glycogen rather than being converted to fat. It is recommended that the last meal consumed before an endurance event be relatively light and contain a mixture of easily digested complex carbohydrate and protein (1). This meal should be eaten about two to three hours prior to exercise to allow time for the stomach to empty. Improvements in exercise performance from pre-exercise carbohydrate ingestion is probably due to a delay in the normal decline of blood glucose during exercise (1). Most likely, this works by supplementing hepatic (liver) glycogen reserves. A recent study has shown that ingestion of one to two grams of carbohydrate per kilogram of body weight one hour before exercise can improve performance (1). In this experiment the carbohydrate was given in liquid form, which is what we would generally recommend if you're going to eat something within an hour of exercise. This allows for more rapid digestion and absorption than is possible with solid food. Pro-Carb Powder™ (original Vanilla or the new Chocolate flavor) is ideal for this, supplying 22 grams of medium-chain carbohydrate (maltodextrin) along with four grams of protein per scoop. That means a 180 pound athlete would need about four scoops taken 30-60 minutes before competing.

> Consuming carbohydrates during exercise can also improve performance. This works by helping to maintain blood glucose levels and preventing hypoglycemia, rather than by sparing muscle glycogen. Keep in mind I'm talking about maximizing exercise performance here, not fat burning.

Consuming carbohydrates during exercise can also improve performance. This works by helping to maintain blood glucose levels and preventing hypoglycemia, rather than by sparing muscle glycogen (1). Keep in mind I'm talking about maximizing exercise performance here, not fat burning. If you're doing aerobics simply to burn fat then you don't want to eat anything during exercise because this will decrease the utilization of body fat as fuel. Competitive endurance athletes may however improve performance by consuming a carbohydrate drink during exercise. This will help replace fluids as well as maintain blood glucose. The rate of gastric (stomach) emptying is key here, as this ultimately controls the availability of the ingested carbohydrate. The stomach empties faster the fuller it is, so it is advised to keep the stomach volume relatively high by taking frequent small drinks. Maltodextrin theoretically should exit the stomach faster than glucose solutions due to its lower osmolality (the concentration of particles in a solution). A rate of about 45 grams of supplemental carbohydrate per hour seems adequate to maintain blood glucose levels during moderate exercise (1). This would be one scoop of Pro-Carb Powder™ every 30 minutes.

Whatever you do, stay away from fructose as an exercise fuel. Fructose is the sugar found naturally in fruit and, ironically, in most sports bars (the Parrillo Bar uses rice dextrin, not fructose). Some people recommend fructose for athletes because it has a low glycemic index and results in a low insulin response. This line of reasoning however fails to consider the big picture of fructose metabolism. Fructose is a bad choice for athletes for two reasons. First, a significant proportion of it is converted to fat by the liver. This is probably the reason it has a low glycemic index and a low insulin response. Second, it does not work well for restoring muscle glycogen. Fructose is metabolized by the liver, not by muscle. Trials with fructose supplementation during exercise have failed to demonstrate an improvement in performance (1) and using fructose as a carbohydrate source to replenish muscle glycogen stores following exercise does not work as well as glucose or glucose polymers (1,2).

Restoration of muscle and liver glycogen reserves after exercise is critical for recovery and subsequent exercise performance (1). I feel it is also very important in order to derive the maximal training effect from exercise, so that you can go out and have improved performance next time. Now we will discuss the type, timing, and amount of carbohydrate needed to maximize recovery of glycogen stores after exercise.

Research shows that glycogen levels can be restored within 24 hours following exhaustive exercise if 600 grams of carbohydrate are consumed (1). This makes good theoretical sense, because most people can store around 400 grams of carbohydrate as glycogen (and maybe twice that much using carb loading techniques). So 600 grams provides enough to replenish glycogen stores plus a little left over to use as fuel during your recovery day. (It is assumed that you will not be exercising during this 24 hour period.) The rate of glycogen synthesis is most rapid immediately following exercise. This is due to several factors, including increased activity of the enzyme that manufactures glycogen, increased permeability of the muscle cell membrane to glucose, and increased sensitivity of muscle to insulin following exercise (1). You should try to consume one to one-and-a-half grams of carbohydrate per kilogram of body weight every two hours for the first six hours after exhaustive exercise and a total of 600 grams during the first 24 hours.

The type of carbohydrate used also affects the degree of glycogen repletion. This effect is most likely due to the glycemic and insulinemic responses of various carbohydrates. Fructose causes a much lower blood sugar level and insulin level than glucose-based carbohydrates.

It is well known that fructose is not nearly as effective as glucose at restoring muscle glycogen (1,2). This is probably because fructose metabolism is essentially confined to the liver. Several studies have compared simple sugars versus complex carbohydrates, with various results. Some studies have found no difference, and some have suggested that simple sugars result in better glycogen recovery during the first 24 hours. One study found that complex carbohydrates resulted in higher rates of glycogen synthesis after 48 hours (1,2). Apparently complex carbs work better over the long term and higher levels of glycogen can ultimately be achieved using complex carbs. My recommendation is to avoid sugar but to use a relatively short chain glucose polymer such as found in Pro-Carb Powder™ or the Parrillo Bar for the first six hours after exercise and then rely on complex carbs for the remainder of glycogen repletion. This should result in optimal glycogen recovery. Simple sugars are more easily converted to fat than complex carbohydrates, and this may be the reason that higher glycogen levels are seen after 48 hours with complex carbs. The complex carbs are more prone to be stored as glycogen while simple sugars more readily spill over into fat stores. The best carb choices for glycogen repletion are complex starches such as rice, potatoes, sweet potatoes, beans, oatmeal, and so on. Contrary to what some proponents of the high fat diet say, current research proves that complex carbohydrates have very little tendency to be converted to body fat (3,4,5).

Several studies have directly compared the effects of carbs versus fat on endurance. One compared a high carb - low fat diet (83% carbs, 3% fat) to a high fat - low carb diet (94% fat - 4% carbs). They found that the group consuming high carbs burned more carbohydrate during exercise and had an endurance time of 210 minutes compared to 88 minutes for the high fat group (2). A high carbohydrate diet results in greater muscle and liver glycogen stores plus helps maintain blood glucose levels longer, resulting in greater endurance. Hard training athletes need extra carbohydrate to support their exercise activity. When a group of athletes was fed a diet containing 40% carbohydrate, their muscle glycogen levels steadily declined over a few days of training. When they were switched to another diet containing the same number of calories but 70% carbs, their glycogen stores were maintained (2). This is very important. It means that not only do athletes need extra calories to fuel their exercise activity, but it also matters where the calories come from. A high fat diet cannot maintain glycogen stores even if it is adequate in calories. This is because fat cannot be converted to glycogen. Also keep in mind that athletes need more protein than sedentary people. This has been proven in many studies using nitrogen balance techniques.

We recommend a diet providing one to one-and-a-half grams of protein per pound of body weight each day with the rest of the calories provided by complex carbohydrates. Try to limit fat to 5-10% of calories. Use high quality, low fat proteins such as chicken breast, turkey breast, egg whites, and fish. Good starchy carbs are things like potatoes, rice, beans, and oatmeal. At each meal you should also include a fibrous carb, such as broccoli, asparagus, salad greens, or other vegetable. Each meal should be balanced, containing one complete protein source, a starch, and a fibrous vegetable. Try to divide your daily grams of protein and your total calories evenly among six small meals. The Parrillo Performance Nutrition Manual contains exact instructions on which foods to eat, which foods to avoid, and how to structure your diet. It also contains a detailed food composition guide and comes with a food scale, so you can determine how many calories and how many grams of protein, carbs, and fat you're consuming. It contains precise directions on how to modify your diet to optimize gaining lean mass or losing body fat.

Regarding supplementation, Parrillo Performance Hi-Protein Powder™ is a high efficiency protein mixture providing a high level of glutamine, branched chain aminos, and essential aminos. This is an excellent way to get your protein intake up where it needs to be. It's now available in chocolate, which is delicious. Endurance athletes and bodybuilders trying to gain weight will do well with Pro-Carb Powder™, a maltodextrin-based carbohydrate supplement. This is an ideal supplement for glycogen repletion and carb loading. We have had great success using it alone or in combination with CapTri® before and during endurance events.

Another product that we've just introduced called 50/50 Plus™ fits this need for additional carbs and protein nicely. With 20 grams of protein and 17 grams of complex carbohydrate in each two scoop serving, 50/50 Plus™ provides your body with the protein necessary to stave off muscle catabolism for energy as well the extra carbs to supply energy when you need it and help replenish glycogen stores when you're finished with your activity. 50/50 Plus™ comes in four delicious flavors — Vanilla, Chocolate, Orange Cream, and Milk — and can be mixed with water or stirred into your food to boost your nutrient levels.
Endurance athletes should also consider Liver-Amino Formula™. This supplement

is the ultimate source of heme iron, which is a superior iron source for building blood cells. Creatine is another supplement that can help extend your energy base. And all serious athletes should be using Essential Vitamin Formula™ and Mineral-Electrolyte Formula™.

Even if you're a bodybuilder and not an endurance athlete, vigorous aerobic exercise will help you get bigger and leaner. Aerobics helps build capillary density in muscle tissue, allowing for better nutrient delivery and more growth. Aerobic conditioning also trains your muscles to rely more on fat as a fuel source but increasing mitochondria and the level of fat burning enzymes (6,7). This helps you get leaner plus spares muscle glycogen for a better pump. Until next time, good training.

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The Ultimate Growth Combo

by John Parrillo

Carbohydrate and Protein — We already know how important these nutrients are individually. Now check out what happens when we put them together!

There are several criteria we must consider when evaluating a nutritional supplement for bodybuilders. First, is there some plausible mechanism by which the supplement might work? This just means is there some logical reason why the supplement should be expected to produce results. For example, we might expect protein supplements to be helpful because they provide the building blocks the body needs to build more muscle tissue. Second, is the supplement actually absorbed by the body and delivered to the site where it's supposed to act? If your supplement is not absorbed into the bloodstream and carried to muscle cells, it probably won't do much. Third, does it produce its effects at the recommended usage level, or is the amount used too small to really be effective. And fourth, the most important criteria is, does the supplement actually produce the desired effect better than a placebo or control. The first few criteria are really asking, "CAN the supplement work?" And the last question is asking, "Does the supplement REALLY work and do what it's supposed to do?"

Unfortunately, few scientifically controlled studies have been performed to specifically evaluate how well nutritional supplements work to help bodybuilders. Many of the supplements out on the market have never been tested to see if they really work. Some of them have been, however. A recent article in the Journal of Applied Physiology (1) tested the effects of either a carbohydrate supplement alone (CHO), a protein supplement (PRO), or else a mixture of carbohydrate and protein (CHO-PRO) to see how the various supplements affected the levels of anabolic hormones in healthy drug-free weight lifters. In addition to merely providing the raw materials for building muscle tissue and storing glycogen, foods and supplements can affect the hormonal environment of the body. In this magazine I have written extensively about how to use food to control various hormone and enzyme levels to create an anabolic environment in the body where nutrients are shuttled to the lean compartment (muscle) while drawing on stored body fat as an energy source. This concept of "nutrient partitioning" amounts to eating in such a way that the food you eat is used to build muscle tissue while your body fat is burned as a fuel source. To me, this is the essence of bodybuilding nutrition. This works because many of the body's anabolic and catabolic hormones are significantly influenced by diet, and it is the levels of these hormones that determines to a great degree whether the calories you eat will be stored as fat or turned into muscle.

> It has been well established that weight lifting causes an increase in growth hormone and, to a lesser extent, testosterone. This is no doubt part of the way in which resistance exercise brings about muscle growth. The question is, can we use any nutritional "tricks" to help this process along.

At Parrillo Performance, we do a lot of "end point" testing of our supplements before a formulation is released on the market. By this I mean we try various formulations of supplements on elite, competitive bodybuilders to find out what actually works. The competitive bodybuilder is the ultimate research lab for studying bodybuilding supplements, because any little change in his or her physique is readily apparent. We follow the athlete's weight, lean body mass, percent body fat, strength on the core lifts, overall "look" and hardness, plus subjective information such as energy level, training intensity, and how he or she feels. By making small changes in formulations we can see how these affect size, strength, conditioning, endurance, and energy level. This is really results-driven testing, because the reason people come to Parrillo Performance is for results. Sometimes (often times, actually) we figure out what works "out in the field" with real bodybuilders before the scientists back in the labs have figured out why or how it works. It's always gratifying when the biochemical research explains some of the results we've seen in the gym, and that's the case with this paper.

It has been well established that weight lifting causes an increase in growth hormone and, to a lesser extent, testosterone (2,3,4). This is no doubt part of the way in which resistance exercise brings about muscle growth. The question is, can we use any nutritional "tricks" to help this process along, above and beyond simply providing the raw materials needed to make more muscle protein? In fact, we can use supplements to improve the anabolic milieu to further enhance muscle growth. The most obvious way to improve the situation is to increase insulin levels, which acts as a potent stimulus to increase muscle amino acid uptake and activate the protein synthetic machinery. Exercise tends to lower insulin levels, which is great because this promotes fat burning during exercise, but then after exercise during the recovery period we want to activate insulin to take advantage of its anabolic properties. This is one time when we don't have to worry so much about insulin causing fat accumulation, for two reasons. First, right after training the muscle cells are hungry for nutrients and they will gobble up all the calories before the fat cells can get them. Second, after exercise glycogen stores are depleted so any carbohydrates you eat at that time will be stored as glycogen rather than being converted to fat.

Carbohydrate alone or in combination with protein (but not protein alone) serves as a potent stimulus for insulin release (5,6). Furthermore, we know that protein feeding stimulates growth hormone and IGF-1. The tension placed on muscle during weight training somehow activates protein synthesis and induces muscular hypertrophy (by some mechanism not yet completely understood) — the question is can we use supplements to enhance this process? If so, do the supplements work by favorably modulating hormone levels to create a more anabolic environment?

To investigate this issue a group of researchers at The Exercise Physiology and Metabolism Laboratory at the University of Texas used a group of nine healthy drug-free weight lifters. Their average age was 25, average weight around 180 pounds at 11.8% body fat, and all had at least 2 years of weight training experience. This is important because it means we can apply their results to real bodybuilders, which is a problem in many studies which use novice trainers and low intensity programs. The subjects were given four different supplements to test: carbohydrate (CHO) which was a mixture of dextrose and maltodextrin, protein (PRO) which was a mixture of milk protein isolate and whey protein, carbohydrate plus protein (PRO-CHO) which was 70% carbohydrate and 30% protein, or else plain water, which was used as the control. This is also good news because the protein and carbohydrate supplements used are virtually identical to the most popular protein and carb supplements used by bodybuilders. The CHO supplement was given at a dose of 1.5 grams CHO per kg of body weight, which works out to be about 120 grams of carbs, or 480 calories on average per supplement dose. Again, this is good news because this is a realistic amount of supplement and we should expect to see an effect, if there is one. The other supplements (PRO and CHO-PRO) were given at equal caloric loads to the CHO supplement, so we can directly compare the effects of the different formulas.

Carbohydrate alone or in combination with protein (but not protein alone) serves as a potent stimulus for insulin release. Furthermore, we know that protein feeding stimulates growth hormone and IGF-1. The tension placed on muscle during weight training somehow activates protein synthesis and induces muscular hypertrophy.

The subjects performed high intensity training sessions going to failure between 8-10 reps on 8 core exercises. Then immediately after exercise and again 2 hours after the exercise session the athletes were given one of the supplement formulas. Before exercise and for the next eight hours after exercise the athletes' blood was monitored for glucose, testosterone, growth hormone, IGF-1, and insulin levels. Thirty minutes after the exercise and the supplement ingestion, plasma glucose levels in the CHO and CHO-PRO groups were significantly elevated compared to the PRO and control groups. Another supplement dose was given two hours after exercise, but this did not seem to further affect blood glucose levels. Going along with this, plasma insulin was significantly increased in the CHO and CHO-PRO groups, and to a lesser extent in the PRO supplement. The combination CHO-PRO supplement actually increased insulin levels to a greater degree than CHO alone. We might not have expected this, since the CHO supplement alone increased blood glucose levels greater than the combination supplement, but keep in mind that protein also serves as an insulin stimulus. So even though carbohydrate alone increases blood sugars levels more, adding some protein to it results in a higher insulin level. So far we can already draw some very important conclusions.

First, when you take a supplement after training you definitely want to include some carbohydrate in it, rather than just using a pure protein powder. This results in a much higher insulin level than protein alone, and this will help drive the amino acids into the muscle. Second, mixing protein along with the carbohydrate further boosts insulin levels beyond carbs alone, which is exactly the effect we want here. We're not too worried about carbs spilling over into fat stores because right after a workout glycogen levels are depleted, so the carbs will be used to replenish glycogen and will not be converted into fat. Third, taking a second supplement dose 2 hours after training has minimal effect on hormone levels. The big benefit seems to come from taking a respectable dose (120 grams in this study) of the supplement as soon as possible after training, and certainly within 30 minutes after you finish your workout. I suggest taking a shaker bottle to the gym with you and drinking your supplement at the gym as soon as you finish training.

Growth hormone levels rose sharply immediately after the exercise bout but declined back to baseline within 2 hours after exercise. The supplements seemed to have no immediate effect on GH levels, but at 6 hours after exercise the GH levels were higher in the CHO and CHO-PRO groups. It seems that the exercise itself has a bigger short-term impact on GH release than the supplements, but by six hours after exercise the effect of the supplements becomes apparent. It is also worth mentioning that the GH increase brought about by the exercise session itself was greater than the GH increase seen at six hours post-exercise, which was attributed to the supplements. This really comes as no surprise, since we know that weight training is really the prime stimulus for muscle growth, not supplements. Plasma testosterone levels were seen to rise sharply immediately after exercise, but then within one hour declined to below pre-exercise levels. All of the supplements resulted in testosterone levels declining below the value seen with water alone. Within 6 hours after exercise the CHO and CHO-PRO groups had returned essentially to pre-exercise levels, but the PRO alone was still depressed. More on this later.

What does this all mean? We know that the early rapid gains seen by beginning weight trainers are primarily due to increased motor learning (1). This means training the nervous system to recruit more muscle fibers to fire simultaneously. The more efficiently the nervous system can activate the muscle, the stronger the contraction. So early on we are mainly training the nervous system. It's not unusual for a novice trainer to basically double his strength in the first six months of training. After a few months of initial training, you likely remember hitting a plateau, where further increases in strength came more slowly. At this point further increases in strength are more closely related to increased muscle mass and muscle cross-sectional area (1). Several factors influence the rate of increase of new muscle mass. These include the volume and intensity of training, the availability of adequate nutritional substrates and calories to support growth, and the hormonal environment of the muscle. If the only purpose of nutrition was to supply the building blocks for growth, then it wouldn't matter that much what you ate. If, however, you want to control the hormones directing the anabolic drive, this takes a more sophisticated approach. The hormones most directly related to muscular growth are insulin, growth hormone, testosterone, and IGF-1. Insulin may potentiate muscular hypertrophy by stimulating amino acid uptake and protein synthesis by muscle. Furthermore, insulin seems to increase growth hormone levels by inducing hypoglycemia (7). This is probably what was happening when we saw GH levels increased by the CHO and CHO-PRO supplements six hours after exercise. The supplements caused an initial increase in insulin levels, which after a few hours resulted in hypoglycemia (low blood sugar) which in turn stimulated GH release.

Several factors influence the rate of increase of new muscle mass. These include the volume and intensity of training, the availability of adequate nutritional substrates and calories to support growth, and the hormonal environment of the muscle. If the only purpose of nutrition was to supply the building blocks for growth, then it wouldn't matter that much what you ate. If, however, you want to control the hormones directing the anabolic drive, this takes a more sophisticated approach.

Probably the biggest surprise was observed with testosterone — all the supplements seemed to decrease testosterone levels compared to plain water. What's up with this? Either testosterone secretion by the testes was decreased, or else possibly the supplements caused more testosterone to be cleared from the blood (maybe by moving it inside cells) thereby resulting in a lower blood level. To investigate this the authors looked at LH (lutinizing hormone) levels. LH is the stimulus for testosterone to be released from the testes, so if the supplements caused decreased testosterone secretion then LH levels should be depressed as well. They found that LH levels were unaffected by the CHO supplement (the only one they tested for this) suggesting that the testosterone level was decreased as the result of increased removal of testosterone from the blood rather than decreased secretion. While it remains to be proven, the authors suggest that plasma testosterone may have been decreased by the supplements as a consequence of increased movement of testosterone into muscle cells, where it acts to promote protein synthesis.

A number of important conclusions can be drawn from this study. You should supplement with a combination of protein and carbohydrate after training because this results in a more favorable anabolic hormonal environment than either protein or carbohydrate alone. You should take the supplement soon after training, within 15-30 minutes. A second dose of supplement two hours after exercise seems to confer little additional benefit in terms of altering hormone levels compared to a single dose. The dose used here was about 120 grams of protein and/or carbohydrate. We agree that this is an appropriate dose size for stimulating growth and optimizing recovery after training. Also, the anabolic hormone most responsive to dietary control is insulin, and to a lesser degree growth hormone (whose secretion is stimulated mainly by protein). This comes as no surprise. Growth hormone and testosterone are best stimulated by intense training. This is why we need a combination of hard training plus a carefully crafted diet to generate optimal hormone levels to maximize muscle growth and fat loss.

Since this study came out a couple of years ago we have used this as a starting point and done some of our own trials here at Parrillo Performance. We have tried various formulations on some top level competitive bodybuilders and fitness athletes and have taken the idea described in this paper a few steps further. First, we found that with our athletes, who train harder and longer than the ones in this study, a ratio closer to 50% protein - 50% carbs works better. Top level bodybuilders just seem to need a little more protein to get that degree of muscle hardness we're going for. Also, we get better results if we use maltodextrin without the dextrose as the carbohydrate source. Dextrose is another name for glucose, a simple sugar. We find that our athletes can pack on more muscle without gaining fat if we leave the sugar out of the formula. Third, we have added glycine (an amino acid) to the formula to further improve its anabolic effect. 50/50 Plus™ contains no sugar and no fat. We have settled on a combination of whey protein and other milk protein isolates to generate what we feel is an optimal amino acid profile.

This new product line is called "50/50 Plus™" to reflect its composition of about 50% protein and 50% carbs. It also provides a good source of calcium and includes vitamins important for muscle repair and growth. We're very proud of this new supplement development. It's designed specifically to promote nitrogen retention and muscle growth. The ideal times to use it are immediately after training, as your first meal of the day to set up an anabolic hormonal environment, or any time as needed with or between meals. The beauty of this product is that it is "programmed" to generate a hormonal environment which results in muscle growth. Not only does it provide the raw materials your muscles need to grow, but it also programs your hormone levels to channel the nutrients into muscle and not fat. It comes in four delicious flavors: chocolate, vanilla, milk (which is great in oatmeal), and orange-cream. I suggest a serving size of 4 scoops if you are using it as a post-workout recovery and growth supplement, 4 scoops in place of a meal, or 2 scoops if used as a calorie boost with or between meals. I think this product is very solid and deserves to be considered a "first line" supplement for bodybuilders. An excellent entry level supplement program would be 50/50 Plus™, Creatine Monohydrate, and the Essential Vitamin and Mineral- Electrolyte Formulas. I think you'll find this supplement might easily push your growth to the next level. The work of hormonal control and nutrient partitioning has been done for you - all you have to do is train hard and take the supplement and you're guaranteed to provide your muscles with the ultimate hormonal milieu for growth.

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The Energetics of Nutrient Metabolism, Part I

by John Parrillo

One of the fundamental problems in bodybuilding is how to gain muscle without getting fat. In order to pack on more muscle we have to be eating enough to supply all of the nutrients and energy we need to grow, but if you're not very careful about how you do this you'll end up gaining as much fat as muscle. This month I want to talk about the correct way to structure your diet to gain muscle and not fat. To do this we first need to review some basic science about nutrient and energy metabolism.

Over the last ten years or so quite a bit has been learned about how diet affects body composition. The old way of thinking was that all that really mattered was calories — if you eat more calories you'll gain weight and if you eat fewer calories you'll lose weight. This concept is referred to as "energy balance." The number of calories contained in a food is a measure of the energy content of the food — calories are a unit of energy. Energy balance is the number of calories you eat minus the number of calories you expend (burn) as energy. If you consume more calories than you burn this results in a "positive energy balance" and the excess calories you consume are retained as body weight (either muscle, fat, or glycogen). If you consume fewer calories than you burn this is a "negative energy balance" and you lose weight. If you consume the same number of calories that you burn this is called "zero energy balance" (or more often simply "energy balance") and your weight will remain constant.

No one doubts the importance of energy balance in determining body weight. It's just that we understand now that there's a lot more to it. Let's say we're trying to gain weight, so we're intentionally eating excess calories. It turns out that what kind of food we choose to supply those excess calories can have a big effect on whether the weight we gain will be muscle or fat. Furthermore, scientific data demonstrates that it is possible to lose fat without cutting calories. The issue we want to explore is if diet composition can affect body composition. Body composition is simply your percent body fat, determined by your pounds of fat and pounds of lean mass. You should monitor your body composition about once a month with the BodyStat Kit to make sure you're gaining muscle and not fat. By "diet composition" we mean the percentage of calories coming from protein, carbs, and fat.

While overall body weight seems to be determined mostly by energy balance (and thus the total number of calories you eat) my theory is that body composition is determined more by diet composition. So what I'm really going to talk about here is how to use nutrition to help you gain muscle and lower your percent body fat. Interested now? First I will review some basics about energy metabolism, then discuss some nutrient balance studies done in humans, and finally wrap up with some recommendations on how to use this information to lower your percent body fat.

Like I mentioned earlier, the old way of thinking was that calories were all that mattered, and what kind of food you ate wasn't considered that important. To understand how diet composition has the potential to affect body composition we need to review the thermodynamics of nutrient metabolism. All food we eat can be used as fuel. If you throw food into a fire it will burn and release heat. Chemically, this process is called "oxidation" because when something burns in a fire its molecules are combined with oxygen from the atmosphere. (This is why fires can't burn without oxygen.) Inside our bodies food molecules are oxidized in a similar process except it occurs more slowly. As the food molecules are oxidized energy is released, just like heat energy is released by a fire. This energy is used to build a special molecule called adenosine triphosphate, better known as ATP. ATP is called a "high energy" molecule because it contains a lot of energy (duh). It contains three phosphate groups which all have strong negative charges! As you remember from high school, like charges repel — negative repels negative and positive repels positive. So the phosphate groups are repelling each other and this makes the molecule want to break apart. When the phosphate groups do break apart this releases the energy which was contained in the ATP molecule. This energy released by ATP breakdown is the immediate source of energy used to power muscular contractions and all of the other work done by the body. After the ATP splits apart some more energy released by food oxidation is used to put it back together again.

So the energy used to fuel our

bodies comes from food, but before we can use this energy it has to be converted into ATP. The thing is that protein, carbs, and fat all follow different metabolic pathways and the energy released from their oxidation is captured as ATP with different efficiencies. Some of the energy generated by oxidation of food molecules is lost as body heat and is not captured by ATP formation. This is referred to as the "thermic effect of feeding" (or TEF) and describes the percentage of energy lost as heat when a particular food substrate is metabolized. The TEF for dietary fat is about 5%, which means that 5% of the energy supplied by the fat is lost as body heat instead of being converted into ATP. The TEF for carbohydrate is around 8-10% and for protein is about 20-30% (1). After we account for all of the energy costs of the various metabolic pathways we find that 90% of the energy supplied by fat is available for ATP production, 75% of the energy from carbs is used to make ATP, and 45% of the energy from protein oxidation is retained as ATP (1).

Therefore it seems obvious that the relative proportions of protein, carbs, and fat in the diet can have a big impact on the amount of dietary energy which is available to perform work or to be retained as body weight. For example let's consider a diet that provides 2000 calories and is made of 20% protein, 30% carbs, and 50% fat. If you do the calculations you'll see that the thermic effect (TEF) of this meal is around 200 calories (or 10% of energy content overall) which means that of that of the 2000 calories you ate, 200 of them are lost as heat. Now let's compare that with a 2000 calorie diet composed of 30% protein, 60% carbs, and 10% fat. The overall thermic effect of this diet works out to be 270 calories (or 14% of energy content). Notice that although both diets contain 2000 calories, the low fat diet provides 70 fewer calories which are available to be stored, because they were lost as body heat during metabolism.

So what does this mean for you as a bodybuilder? Look at it this way: the diet higher in fat provided 70 more calories which can be used as energy or retained as body weight. These 70 "extra" calories are in the form of fat. Fat cannot be converted to carbohydrate or protein, therefore these 70 calories could not be stored as glycogen or muscle. They could only be stored as fat. Therefore the high fat diet has the potential to result in 70 calories worth of body fat storage more than the low fat diet. This is far from the whole story however. These considerations are just meant to demonstrate that two different diets which provide the same number of calories can result in a different effective energy balance. This concept is known as "food efficiency" and has been around in the livestock industry for years. It has long been recognized that feeding different diets to growing animals (say young pigs or cattle being raised for meat production) will result in different growth rates. A diet with a higher food efficiency will result in more retention of energy as body weight (i.e., more growth) for a given number of calories. In practice, however, diets with a high food efficiency result in more body weight gain because the animal retains more fat.

> Unfortunately, the body cannot convert dietary fat into carbohydrate or protein, so if you consume excess calories in the form of fat they will be retained as adipose.

If all the food energy we eat is converted into ATP then how do we gain body weight? Well, in the situation of positive energy balance we are eating more calories than we burn. In that case not all of the food is burned and instead the portion that is not used as fuel is retained as body weight — either muscle or fat or glycogen. If the "excess" calories are supplied as carbohydrate they will be stored as glycogen until the glycogen stores are completely full. After that any more carbs can be converted to fat, but as we will see later this almost never actually happens. If the excess calories are supplied as fat they will be stored as fat, plain and simple. Unfortunately, the body cannot convert dietary fat into carbohydrate or protein, so if you consume excess calories in the form of fat they will be retained as adipose. I'd like to say excess calories supplied as protein will be retained as protein in muscle, but it doesn't work that way. Gaining muscle is not as simple as consuming excess protein energy. Extra calories you eat as protein can be retained as protein or else converted into glycogen (via gluconeogenesis) or fat. When we get to the discussion of the nutrient balance studies later in this article, I'll explain some factors that determine whether excess calories are retained as glycogen, fat, or muscle.

Let's talk about how we can use these concepts. Let's say we want to lose fat and lower our percent body fat. We all know that the fastest way to lose weight is to cut calories. There are several problems with this approach however. First, somewhere between 25-50% of the weight lost during energy restricted diets is muscle, depending on the severity of the energy deficit. This is unacceptable for bodybuilders. Second, energy deprivation will eventually slow down your metabolic rate so you will be burning fewer calories. Weight loss will eventually plateau, until you cut calories even further. Third, energy restricted diets cause an increase in the enzymes that make and store fat, so that when you remove the energy restriction (start eating normally again) the first thing that happens is you gain back the fat you lost. These adaptations are known as the "starvation response" and represent your body's attempt to defend it's fat stores in the face of energy deprivation. Your body perceives the energy deficit created by the low calorie diet as a famine and tries to hang onto it's fat stores as long as possible so it can survive. These are the reasons low calorie diets ultimately result in failure about 90% of the time. But what if instead of cutting calories we shift to a lower efficiency diet. We still consume the same number of calories as usual, but now a higher percentage of the calories are lost as body heat during metabolism. This will result in weight loss (an effective negative energy balance) without reducing calorie intake and setting into play the starvation response. Metabolic rate will remain high and we won't lose muscle. So these considerations about the energetic efficiency of nutrient metabolism allow us to design a diet which will result in fat loss without cutting calories, slowing metabolic rate, or losing muscle. Pretty slick, huh?

Next, I want to discuss some experiments done with humans to monitor what happens to the nutrients we eat under different dietary conditions (2-5). In the last few years it has become clear that overall energy balance really has three separate components. The nutrient energy supplied to the body comes in the form of protein, carbohydrate, and fat. These are called "macronutrients" because we consume them in large amounts, in contrast to the "micronutrients" like vitamins and minerals which we consume in small amounts. Protein, carbs, and fat follow different metabolic pathways. It turns out that the protein compartment of the body, the carbohydrate compartment, and the fat compartment are all regulated separately, although what happens in one compartment will obviously affect the others. So we have a protein balance (usually called "nitrogen balance" since most of the body's nitrogen is contained in amino acids) which describes the balance between protein intake and protein utilization. A positive nitrogen balance means we're gaining protein mass, which effectively means we're gaining muscle mass. Similarly there is a fat balance which describes the amount of fat intake versus the amount of fat burned for energy. A negative fat balance means we're losing body fat. And last is the carbohydrate balance, which is the amount of carbs consumed versus the amount used as fuel. A positive carbohydrate balance means we're storing glycogen and a negative carb balance means we're losing glycogen. Got it?

.........if our goal is to lose fat we must achieve a negative fat balance, and this is not necessarily the same thing as a negative energy balance. To lose fat what we have to do is to burn more fat than we eat — in this situation we will be in negative fat balance and the fat which is burned in excess over what we consume must be derived from adipose depots.

Since the forms of energy consumed and stored by the body are carbohydrate, protein, and fat then it makes sense that overall energy balance is determined by the sum of protein balance, carbohydrate balance, and fat balance. And although the protein, carb, and fat balances can affect each other, they are regulated separately. As simple as it sounds this has only been understood for about the last 10 years, and is still somewhat controversial. This has dramatic implications for bodybuilders and, for that matter, anybody wanting to lower their percent body fat. As you can see, if our goal is to lose fat we must achieve a negative fat balance, and this is not necessarily the same thing as a negative energy balance. To lose fat what we have to do is to burn more fat than we eat — in this situation we will be in negative fat balance and the fat which is burned in excess over what we consume must be derived from adipose depots. To lose fat it doesn't really matter what your overall energy balance is, just so you have a negative fat balance. If you think about it, it's really the protein balance that determines how much muscle mass we have and the fat balance that determines how much body fat we're carrying. So these nutrient balances (and not energy balance per se) are what determine our body composition. And nutrient balance is largely determined by diet, since the diet establishes the input side of the balance equation. The studies I want to discuss have looked at how the fat, carbohydrate, and protein balances are regulated, how this relates to overall energy balance, and how all of this is affected by changes in diet. Afterwards it will become clear how you can make changes in diet composition to influence changes in your body composition.

The first paper I want to review examined what happens if we feed people an excess of calories supplied as carbohydrates (2). For this experiment six healthy young men were fed a test meal containing 480 grams of carbohydrate, which is about twice as much carbohydrate as an average person would eat in a whole day. Overall the meal consisted of 93% of energy (calories) as carbs, 5% protein, and 2% fat. To monitor nutrient metabolism the respiratory quotient (RQ) was monitored by indirect calorimetry over the next 10 hours. What does that mean? Each of the different macronutrients (protein, carbs, and fat) require different amounts of oxygen to burn. When a food molecule is completely burned it is converted into carbon dioxide (CO_2) and water (H_2O). A fat molecule contains very few oxygen atoms, so when you burn a fat molecule it can combine with a lot of oxygen molecules. So if you are burning fat for fuel you will consume a lot of oxygen. A sugar molecule (a carbohydrate) contains some oxygen atoms already built into the molecule, so when it is burned it consumes less oxygen. In other words, from a chemical point of view the carbon atoms in a carbohydrate molecule are already partially oxidized, so you can only add so much more oxygen when you burn it. The carbon atoms in a fat molecule are fully reduced (which is the opposite of oxidized) so when you burn fat more oxygen is consumed than when you burn carbohydrate. Protein works out to be in between.

So what you do is place the person in a room or a special chamber where you can monitor how much oxygen he consumes and how much carbon dioxide he produces, and from this you can calculate if he's burning carbs or fat for energy, and how much of each. To monitor protein metabolism urine samples are collected and the amount of protein utilized can be determined from the amount of urea nitrogen excreted in the urine. Indirect calorimetry is a special technique where we monitor oxygen consumption and carbon dioxide production and from that determine how much protein, carbs, and fat are being burned as fuel. The respiratory quotient (RQ) is the ratio of carbon dioxide produced divided by the amount of oxygen consumed, and this (along with urinary nitrogen excretion) is what tells us what mixture of protein, carbs, and fat is being used as the fuel source (the substrate mix, or fuel mix).

Some amazing things were discovered with this experiment. Most people would think that if you overfeed that many carbohydrate calories at one sitting you would store the excess energy as fat. But that's not what happened. During the ten hours following administration of the test meal, 133 g of carbohydrate, 17 g of fat, and 29 g of protein were oxidized (burned). Disposal of the 480 gram carbohydrate load was accounted for by oxidation of 133 grams, storage of 346 grams as glycogen, and conversion of less than 3 grams into fat. Probably most exciting was that during this same time 17 grams of fat were burned. The diet only provided 8 grams of fat, so the subjects actually lost fat as a result of the test meal, even though it contained excess calories.

This study demonstrates that feeding excess calories in the form of carbohydrate results in glycogen storage, but not fat storage. Feeding excess energy as carbohydrate increases the rate of carbohydrate oxidation, so if you eat more carbs you burn more carbs. This effect minimizes any conversion of carbs into fat. If you consume excess calories in the form of carbohydrate they will mostly be burned as energy or else stored as glycogen. Subjects in this study actually had a negative fat balance (i.e., lost fat) even after carbohydrate overfeeding. But don't get too carried away with this. This experiment was just overfeeding carbohydrates for one meal. If this was continued over a few days eventually glycogen stores would become saturated and then I expect we would see net fat storage begin to occur. The conclusions from this paper are that acute (short-term) carbohydrate overfeeding increases carbohydrate oxidation, so that if you eat excess calories in the form of carbs some of the excess will simply be burned and lost as heat. The remainder will be stored as glycogen, but will not be converted to fat. Next month I'll pick up the discussion with an experiment to test what happens if we consume excess calories in the form of fat. And it ain't pretty.

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