ALBION MINERALS
Human Nutrition

RESEARCH NOTES

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Minerals: Key Role Player in Recovery Nutrition

The science behind recovery nutrition has been growing steadily, and its importance to the subsequent performance of athletes, weekend warriors, and individuals who work out in one form or another is without question. Nutrition scientists divide recovery nutrition into three parts: **Refuel, Rebuild, and Rehydrate**. The strategies for recovery, of course, are predicated by the demands of the specific sport or type of exercise involved, but these three parts are key to the recovery process. The science behind recovery nutrition now indicates that carbohydrates, proteins, fluids, and electrolytes help get the body refueled and rehydrated, and also has the necessary ingredients to repair and rebuild muscle tissue (*according to Amanda Carlson-Phillips, Core Knowledge, August 5, 2015*). All three energy systems (immediate, glycolytic and oxidative) are involved in the bioenergetics of exercise, with each contributing according to the intensity and duration of the performance. The better the recovery nutrition program, the better the physiological status will be for the person embarking on the next physical event. In general, marathon runners, swimmers, or long distance runners (over 15-20 minutes) rely more on carbohydrates for their fuel, while weight lifters and sprinters rely more on the ATP, ADP and creatine systems for fuel.

REFUEL

Refueling should take place in the first 15 to 60 minutes (the sooner the better) following rigorous exercise or a competitive event. When one starts to perform a type of exercise or competition, the body's primary fuel is muscle glycogen (see chemical structure in fig. 1). Because the body uses carbohydrates to form glycogen, loading up with carbohydrates is one of the biggest nutritional advantages for the endurance performer. Once the stored muscle glycogen is depleted during an exercise performance, the body starts to burn stored fat along with proteins and other carbohydrates to continue working. **Studies have shown that the level of pre-exercise muscle glycogen is the most important determinant of exercise performance**. It has been demonstrated that the sooner one consumes carbohydrates after exercise performance, the body's glycogen synthesis and storage is maximized. Why? Because this is the time when glycogen synthase is most active, making the body most receptive to carbohydrate intake.

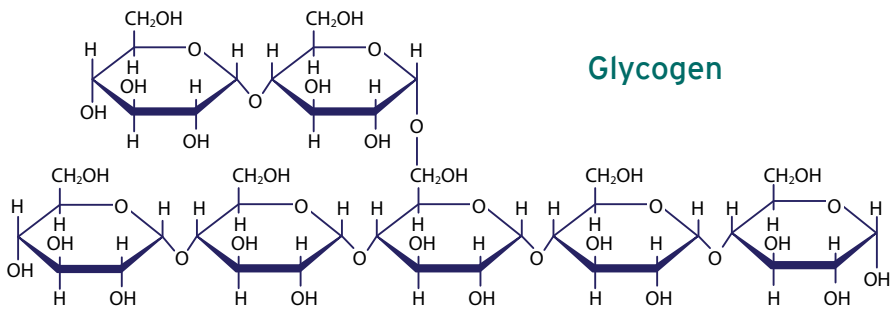


Figure 1.
Glycogen is a polymer of glucose residues. The chains and branches are larger than shown. (*www.rpi.edu –Rensselaer Polytechnic Inst.*)

Glycogen is found in most tissues of the body, especially the liver and skeletal muscle. Muscle glycogen, a glucose polymer, is the body's energy source for the first 60 – 90 minutes of exercise performance. The formation of glycogen from carbohydrates and subsequent utilization for muscular energy is a very complex system involving many steps and interrelationships within the liver and muscle tissues. **Minerals play a number of key roles in generating and utilizing energy. Magnesium, calcium, zinc, and phosphorus are key players in glycogen formation and subsequent utilization.** These minerals provide the actual energy needed for physical performance and muscle contraction as well as relaxation (preparing for the next contraction). Magnesium plays the largest role of all the micronutrients in the body's energy cycle and is the most useful in the refueling segment of recovery nutrition. Magnesium is the catalyst or cofactor in many of the oxidative phosphorylation reactions, converting sugars into glycogen and ultimately ATP needed for refueling in preparation for future exercise or athletic performance.

As we exercise, the body burns through our glycogen stores. The longer and the more intense the exercise, the more glycogen we burn. Fast glycogen recovery or refueling is most important in athletes who train multiple times per day or participate in back-to-back events. In these individuals a proper refueling strategy is essential, otherwise they put themselves at risk for poor performance and even injury. Recovery of fuel stores is estimated to require between 0.8 and 1.2 grams of carbohydrate per kilogram of body weight consumed as quickly as possible after the exercise event. Simple sugars or complex carbohydrates are the best choice for refueling. In the post high-glycogen burning workout, the body will accept anything to refuel (simple sugars or complex carbohydrates) due to its dire need of refueling. However, complex carbohydrates allow for a greater volume of calories to be absorbed than simple sugars. Competing or training multiple times per day requires that athletes have a good short-term recovery plan that includes:

1. Synthesis of the body's carbohydrate stores (glycogen)
2. Rehydration
3. Rest

REBUILD

In the process of performing an athletic event (whether it be endurance running, cycling, weight training, football, hockey, basketball, or sprinting), muscle tissue is exposed to potential damage. The more intense the exercise, such as weight resistance training to the point of muscular fatigue, the greater the potential or likelihood for excessive catabolic effects - muscle breakdown, or damage. Research findings indicate that the heavier the training, the greater the increase in levels of circulating catabolic hormones is needed by the body to facilitate the breakdown of glycogen and fat for fuel to continue muscle performance (*Today's Dietitian* (*vol.15, no.11, 2013*). These catabolic hormones remain high after exercise and continue to breakdown muscle tissue. Without proper nutrient intake of protein, this catabolic condition can continue for hours resulting in increased muscle soreness and poor subsequent performance. Repairing and building muscle requires the athlete to take in high amounts of protein immediately after exercise, especially after resistance training. The amount of protein needed will vary with the type and length of exercise performed. Protein drives the body to create and repair damaged muscle tissue – aiding in the synthesis of muscle protein, the key process for building muscle. According to Yan,Y., et al (*Br J Nutr. 2012; 108 (10); 1780-88*), in order to repair and build muscle, athletes need to refuel with high protein foods immediately following exercise, especially after resistance training. Athletes should consume 20 to 40 grams of protein that includes 3 to 4 grams of leucine per serving to increase muscle protein synthesis. Studies have shown that whey protein is the optimal post-workout protein due to its amino acid composition and the speed of its amino acid release into the bloodstream. Athletes need to eat protein regularly throughout the day in order to stimulate whole body protein synthesis.

Creatine is involved in building muscle and providing fuel for muscle contraction. Clinical studies have shown that adding creatine to the diet will increase muscle mass when combined with weight resistance training. In the cycle to produce ATP, both creatine and magnesium are involved which is why magnesium creatine chelate (Creatine MagnaPower®) was invented. In a clinical study comparing the effectiveness of Creatine MagnaPower® to creatine monohydrate administered with magnesium oxide, **the researchers concluded that positive changes in quadriceps peak**

torque were significant only in the magnesium creatine chelate group which had greater increases in intracellular water that may infer more muscular creatine due to an osmotic effect. An increase in intracellular hydration is associated with increased protein synthesis (muscle growth). (*Brilla,LR, et al, Metabolism, vol.52, No.9 2003, pp1136-1140*).

In rebuilding muscle, other minerals are involved. **Research has shown a positive correlation between magnesium levels and lean tissue growth (protein synthesis)**. Magnesium has a positive impact on testosterone production. Optimum magnesium intake increases levels of growth hormone and IGF-1, all needed for optimum increases in muscle growth. Zinc has an impact on muscle growth due to its stimulation of testosterone production, which leads to an anabolic effect – muscle growth. Of course, phosphorus is important for ATP formation.

REHYDRATE

This part of recovery is aimed at replacing body fluids and electrolytes lost in sweat during the performance of exercise. Athletes should consume 20-24 ounces of fluid per pound lost during exercise. It is also a good idea to drink a glass of water an hour before exercise. The main electrolytes involved in recovery are **sodium and potassium; these are key minerals that can be lost during exercise** through the sweat glands. What do sodium and potassium have to do with exercise? They play roles in muscle contraction. To initiate muscle contraction, nerves release acetylcholine which binds to acetylcholine receptors which in turn cause an influx of sodium ions that depolarize the cell membrane and releases, calcium, which then phosphorylates various enzymes that phosphorylates the myosin heads, enabling the muscle to contract. To repolarize the membrane after a short time, potassium channels open up allowing potassium to flow thereby repolarizing the membrane. Ionic homeostasis is then re-established by pumping sodium out of the cell and potassium in. An excess loss of sodium or potassium can lead to muscle cramps.

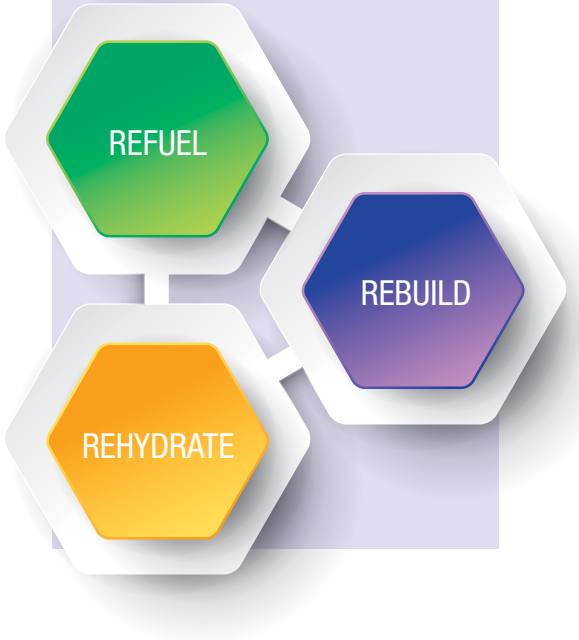
SUMMATION

Recovery from athletic performance is a new science in nutrition that consists of refueling, rebuilding, and rehydration. Refueling requires ingesting complex carbohydrates or even simple sugars, although ingesting complex carbohydrates to refuel is more efficient in providing the starting point to produce glycogen. Glycogen is a bit more important for endurance athletic performance. Athletic performance of intense, short-term duration is more reliant on the creatine, ADP, ATP energy system for their refueling.

Refueling process involves magnesium, calcium, zinc, and phosphorus for the formation of glycogen and ATP.

Rebuilding process, or the regeneration and growth of muscle tissue, is important for all athletic performance but acutely for the weight trainers, hockey players, etc. The key minerals for rebuilding are magnesium, zinc, and phosphorus.

Rehydration process relies on liquids and electrolytes, particularly sodium and potassium.



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