

Module 10, Lesson 2 Handout:

Carb Loading

Before we get into the how of carb loading, let's review the why. It starts with glycogen, which as a reminder is a form of glucose stored mainly in skeletal muscles and the liver (we also have very small amounts of glycogen in brain cells, heart cells, kidney cells, red and white blood cells and even fat cells.) We store about 400 to 500 grams of glycogen in skeletal muscles and about 100 grams in the liver, though this varies widely based on body mass, diet and fitness. The main job of liver glycogen is to make sure we have a steady stream of glucose in the blood (about 4 grams) to bring energy to our brains, while the glycogen stored in muscles is used to fuel our muscles. Muscle glycogen is the main thing to consider for exercise.

How Muscles Use Glycogen for Energy

Let's start by discussing exactly how our muscles get fuel during exercise. Structurally, glycogen is essentially a large chain of glucose molecules connected by glycosidic bonds. When the muscles need energy, the chain can be broken apart, freeing individual glucose molecules to be used for energy. This process is called glycogenolysis - the breakdown of glycogen. Once individual glucose molecules are freed, they can undergo glycolysis to make ATP energy to fuel muscles. During intense or prolonged exercise, muscle glycogen is broken down quickly. The more intense the exercise, the faster muscle glycogen is broken down.

Basics of Carb Loading

Muscle glycogen doesn't last forever and that feeling of "hitting the wall" is a signal that glycogen stores have run out. The last thing an athlete wants is to run out of fuel during an event. It's well established that beginning an event with ample muscle glycogen stores will improve exercise performance. Research has found that starting a 90+ minute endurance event with elevated muscle glycogen content can postpone fatigue by about 20% and that high carbohydrate diets can improve performance by 2 to 3%.

So how do you do this? Carbohydrate loading can help. The idea behind carb loading is to bump up carbohydrate intake to 60 to 75% of energy intake prior to an event to increase muscle glycogen stores and prepare muscles. The key here is that this best works when done over a period of time - carb loading isn't just eating a huge plate of pasta the night before a race. Some protocols call for carb loading for four days prior to an event, but there's other research showing athletes will find more success continually following a high carbohydrate diet plan where carbs provide more than 60% of daily energy. Following a plan that supplies enough carbohydrates and calories to meet or

exceed daily expenditures during the regular training schedule can result in what scientists call “supercompensated muscle glycogen stores,” meaning muscles are able to hold more glycogen than they normally would be able to.

Bottom Line

Rather than recommending a fettuccine feast the night before an event, design a client’s plan to provide plenty of carbohydrates every day and recommend nutrient dense options like oats, sweet potatoes, rice, winter squash, beans, and whole and ancient grains. Some studies have found 5 to 6 grams of carbohydrates per kilogram body weight per day (so, 320 to 380 grams for a 140 pound female) to be sufficient to maintain optimal muscle glycogen levels that can sustain the demands of an intense training schedule. However, athletes with very intense training regimens (think endurance runners or swimmers, ice hockey players, or anyone who cannot speak during the exercise) may need up to 8 to 12 grams of carbohydrates per kilogram body weight each day.

Also, keep in mind it’s not just about carbs to maintain muscle glycogen stores; protein is needed to stimulate muscle recovery, repair and growth. Research has found that eating protein along with carbohydrates immediately after exercise may be beneficial in replenishing glycogen stores (a process called glycogenesis.) Research finds eating 0.3 to 0.4 grams protein per kilogram body weight post is optimal. Exercise itself has been shown to optimize muscle protein synthesis. .

For long events such as marathons or endurance cycling races, you can also recommend fueling during the event as we discuss in another handout. Goos, chews, sports drinks, gummies, hard candy and actual foods like applesauce and raisins can be great tools to maintain and replete glycogen stores and prevent hitting the wall and keep endurance levels high.