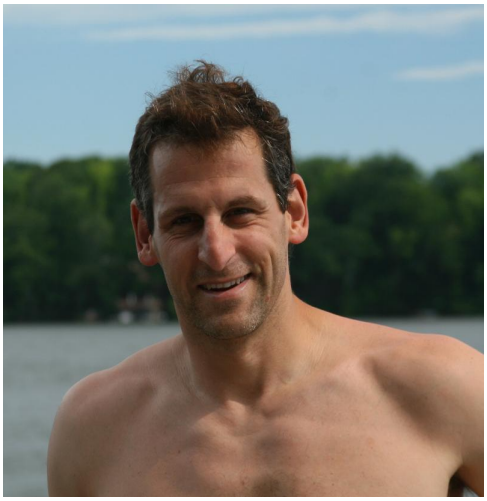
I am very excited to introduce to you Brian Goldman.

Brian is a swimmer and has been from age 7. He has always swum competitvely (AAU and USS), and also with USMS! He now swims with RAM.

He currently practices medicine at the Raleigh Medical Group. Brian has been one of the team physicians for the NC State Wolfpack athletic department for the past 10 years.

Below is the first in a 4-part series of articles by him about nutrition for the athlete.



The Doctor Is In…the water

by Brian Goldman, MD

Our diet is made up of minerals and three categories of macronutrients: **carbohydrates, protein and fat**. They provide energy to maintain bodily functions during rest and physical activity. They serve as biologic fuel and preserve the structural and functional integrity of the organism. We could not survive without each component. The key to smart eating is to understand what we use each for and how we can best choose the components to achieve our goals of healthy living. In this article I will talk about carbohydrates. In the following articles I will pick up the thread and talk about fat (lipids), protein, and vitamins and minerals.

Carbohydrates

Carbohydrates are formed from atoms of carbon, hydrogen and oxygen. These atoms form molecules that are classified as **monosaccharides** (“one sugar”), **oligosaccharides** (“few sugars”) and **polysaccharides** (“many sugars”) depending on how many sugar components are linked within each molecule.

The **monosaccharides** are glucose or dextrose, fructose and galactose. Glucose is found naturally in food and the body. Fructose is fruit sugar and is the sweetest sugar. Look for it in fruit and honey. Galactose is found in mammary glands of lactating animals. It can be converted to glucose for use in energy metabolism.

Oligosaccharides are double sugars. They include sucrose, lactose and maltose. Along with monosaccharides, oligosaccharides comprise the simple sugars.

Polysaccharides, which come from plant and animal sources, are linked simple sugars from three to thousands of sugar molecules. Starch and fiber are common forms of plant polysaccharides. Starch is found in seeds, corn, and various grains. We commonly consume them as bread, cereal, pasta and pastries. The term complex carbohydrate is used to describe dietary starch because their molecular structure (long chains of simple sugars).

Like starch, fiber only comes from plants. There are water-soluble and water-insoluble fibers. The relative amounts of each type of fiber vary from plant to plant. Water-soluble fiber will lower cholesterol. Water-insoluble fiber may be effective in reducing ones risk for colon cancer. For example, bran cereal is significantly higher in insoluble fiber while apples and potatoes contain more soluble fiber than insoluble.

Not all carbohydrates are physiologically equal. Food containing fiber takes longer to digest and will release glucose more slowly, minimizing surges in blood glucose. Low fiber, processed starches and simple sugars digest quickly and enter the blood at a more rapid rate after being consumed. This leads to a surge in insulin that will elevate plasma lipids and accelerate fat production. Over time the body’s sensitivity to insulin will be reduced. This may result in diabetes as the pancreas struggles to produce enough insulin to naturally counter the rising blood glucose.

Glycogen is the package in which carbohydrates are stored by animals, predominantly in their muscle and liver tissue. It is formed from linked glucose molecules. The body stores approximately 500 g of carbohydrate (80 kg man), most of which is muscle glycogen (80%). Most of the rest is liver glycogen and only a tiny amount is in the blood as glucose.

Glucose can be converted by metabolic processes in the body into chemical energy. Each gram of glucose contains approximately 4 kCal (calories) of energy that can be used to perform mechanical work like flexing muscles. Our bodies rely on carbohydrates as ready fuel for high intensity exercise.

Carbohydrate Dynamics in Exercise

The liver increases glucose release to active muscles for metabolic fuel as exercise intensity increases. Muscle glycogen supplies the predominant carbohydrate energy source during the early stages of exercise and as intensity increases. Carbohydrates are preferred over fat and protein sources of energy for intense aerobic exercise and are the sole fuel source in anaerobic exercise. Can you guess what happens in an individual who is on a low carbohydrate diet? Just three days of such a diet can depress all out exercise capacity due to lack of readily available stored glycogen, our main fuel depot.

In high intensity exercise, liver glycogen has been depleted by about 55% after an hour. A 2-hour strenuous workout almost depletes the glycogen contained in the liver and muscles.

In moderate and prolonged exercise, glycogen from muscles initially provides the energy during rest and up to moderate exercise. As exercise intensifies, energy supplies shift to liver and muscle glycogen stores along with fat catabolism with some protein sources of energy. If the intensity is lower, fat is the main energy substrate. The circulating blood glucose levels can get dangerously low if the liver runs out of glycogen stores since blood glucose supplies are not very large. Low blood glucose levels can be dangerous since the brain and red blood cells rely completely on available circulating blood glucose. As fat becomes the primary energy source, intensity will have to slow down by about 50% since fat is more slowly oxidized in aerobic conditions.

In addition, in individuals with glycogen depletion, amino acids formed from protein breakdown become an important energy source. Adequate stores of glycogen will spare this protein breakdown and preserve muscle mass.

Experiments that demonstrated that a carbohydrate-deficient diet leads to decreased performance in short-term anaerobic exercise and prolonged intense aerobic activities have been performed on athletes.

The **take home message on carbohydrates** is this: Carbohydrates are an efficient source of metabolic energy. Carbohydrates are essential in promoting protein sparing with intense exercise. Inadequate stores in our muscles and liver will lead to decreased performance especially in endurance athletes. All carbohydrate sources are not equal. Fiber rich sources like fruits, grains and vegetables should be the primary sources of carbohydrates. A healthy diet will contain approximately 60% of total calories from carbohydrates. The percentage may need to go even higher with increased training intensity.