The Doctor Is In … The Water

By Brian Goldman, MD

In the previous article I expounded upon carbohydrates, those energy packets that eventually are used by our body for muscle contraction and other energy consuming activities or get stored as glycogen. This month I will bring to light some information on fats also known lipids. Lipids are the second macronutrient on my hit list, the others being carbohydrates and protein. After reading this I expect all masters swimmers to be more conversant in lipid properties and some fun to know facts about lipid metabolism in athletes.

Let's get started while the water is warm…

Lipids have many roles in the body. I will only touch on a few:

Lipids are an important energy source and reserve: Lipids provide a large quantity of energy per unit weight, approximately 9 kcal per gram compared to only 4 kcal/gram for carbohydrates. The amount of stored lipid in our body dramatically outstrips the amount of stored carbohydrates by many thousands of available calories.
Lipids can be used instead of protein for energy thus sparing muscle tissue.
Lipids are a hunger suppressant.
Lipids are a thermal insulator, protecting us from the cold.
Lipids actually protect our internal organs from jarring shocks.

A little talk about the chemical side of things
If the mention of words like atoms, molecules and various elements tends to turn you green or squeamish please skip over the following few paragraphs until you reach the asterisk (*) below. You will be safely past the scary stuff.

Lipids are composed of carbon, hydrogen and oxygen. They differ from carbohydrates in the ratio of carbon, hydrogen and oxygen atoms. Amongst lipids, the ratios vary as well which leads to the differing properties of the various lipid types.

Lipids can be categorized as simple, compound and derived.

Simple lipids include triacylglycrerols or triglycerides (TGs).. TGs are formed from a 3-carbon glycerol molecule with 3 fatty acid (FA) chains attached. (Glycerol is different from glycogen, folks.) FAs are composed of carbon chains with attached hydrogen atoms. FAs vary in the number of carbon atoms (length) and the number of hydrogen atoms linked to the carbon backbone chains. A carbon chain with the maximum number of hydrogen atoms attached is "saturated" or completely filled with hydrogen. A carbon chain with one or more available sites for hydrogen atoms is called "unsaturated" since additional hydrogen atoms could, in theory, be added to the chain changing its structural and, subsequently, its physical and chemical properties. A single unsaturated molecule is called "monounsaturated". A molecule with multiple unsaturations is part of a polyunsaturated fatty acid.
Molecules that are identical in structure and longer tend to line up nicely and will gel or become solid at room temperature. Molecules with more unsaturations will have kinked molecular structures. They will not line up as easily and will be more liquid at room temperature. All fatty acids tend to be hydrophobic (repel water) which gives them their oily nature.

Saturated fatty acids (SFAs) are found in animal products like meat, dairy, egg yolks and in certain plant oils like coconut, palm vegetable shortening and hydrogenated margarine.

Note to the reader: **Hydrogenation** is the process of changing oils to semisolid fats by bubbling liquid hydrogen under pressure into vegetable oil. This process adds hydrogen atoms to the unsaturated chains which then become saturated with hydrogen.

Unsaturated fatty acids include mono and polyunsaturated fatty acids. **Polyunsaturated** fatty acids (PUFAs) include safflower, sunflower, soybean and corn oil. **Monounsaturated** fatty acids (MUFAs) include canola, olive, peanut, almond, pecan and avocado.

Trans fatty acids (TFAs) are formed from the partial hydrogenation of unsaturated corn, soybean or safflower oil. They are often found in baked or processed foods.

SFAs and TFAs have an adverse effect on blood cholesterol. They both raise the "bad" low density lipoprotein (LDL) cholesterol while TFAs also lower the "good" high density lipoprotein (HDL) cholesterol concentrations. PUFAs tend to lower the LDL while MUFAs may raise the HDL. A prudent diet would include 20-35% of caloric intake be fat. The American Cancer Society recommends closer to the 20% number to be of fatty origin. Most of the fat content in the diet should be MUFA or PUFA with only 7-10% being SFA.

Compound lipids: These are triglycerides combined with other chemicals such as phosphorus and nitrogen containing molecules. These new molecules called **phospholipids** can interact with water and lipid to perform unique cellular functions. Other compound lipids include **lipoproteins**. The latter transport TGs and cholesterol throughout the body via the blood stream. They include chylomicrons, HDL, LDL, and VLDL (very low density lipoprotein). Their interaction is complex and is beyond the scope of this article. A quick take home message would be that we want to elevate HDL as much as possible through exercise and a diet high in MUFA and omega 3 fatty acids (a kind of PUFA). You can lower your LDL through a diet low in fat and high in fiber.

Derived lipids include **cholesterol** and all of the molecules formed from cholesterol. Cholesterol is found in animal products. It is also made in our cells. Higher production of cholesterol results from a diet high in SFA and TFA. It is a well know fact that one's coronary artery disease risk is reduced when efforts at cholesterol reduction are pursued through diet, exercise and if necessary, medication. High concentration of cholesterol molecules can lead to the development of atherosclerotic plaque in the lining of the arteries. Plaque buildup can lead to narrowing and subsequent injury to the organs supplied by those vessels.

(*) asterisk (*) It is safe to start reading again…

Fat Dynamics during Exercise

Fat supplies 30-80% of energy for physical activity depending on nutritional status, physical status, exercise intensity and exercise duration. With light to moderate exercise, the amount of fat consumed for energy increases three fold when compared to resting energy use. With increased intensity, fatty tissue releases fatty acids. With an increase in intensity, muscle glycogen use picks up. Fatty acid from triglycerides is the main energy source for light to moderate exercise. After an hour of more intense exercise, fat becomes the major supplier of energy due to glycogen depletion. This is dependent on glycogen stores and exercise intensity. At some point fat can be the source for up to 80% of total energy required.

Effects of Conditioning

Aerobic exercise training, especially of mild to moderate intensity, increases the body's use of fatty acid as an energy source. Intramuscular triglyceride combustion will increase with training. This will lead to a decrease in energy consumption of carbohydrate fuel sources in the trained athlete. As a result, endurance athletes can exercise at a higher intensity level (just below maximum capacity) for longer periods of time before they hit a wall caused by glucose depletion. At this level of exercise, the trained athlete has a higher capacity to burn fat.

Summary

Fats or lipids are an essential part of our diet.
They are power packed with energy and contain almost twice as many calories per gram as carbohydrates.
Depending on the molecular structure, lipids will have varying chemical and physical properties.

A diet high in SFA and TFA can have harmful effects on our bodies.
Lipids are a huge energy source for us. They are primarily consumed in light to moderate exercise and with prolonged exercise after glycogen stores have been reduced or depleted.
Well-conditioned athletes can burn off lipids at higher levels of exercise intensity. This allows for longer periods of higher intensity exercise. Glycogen stores can be preserved, as a result, and protein can also be spared as a source of energy.

Happy reading folks…I look forward to seeing you with a gram of protein in my pocket the next time THE DOCTOR IS IN…THE POOL.