Comments on Physiology

Richard E. Ecker, Ph.D.

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In my previous discussions, I have considered in some detail the importance of carbohydrate fuel for long-distance running. I think there is no question that "the wall" as it is experienced by most runners is the simple consequence of carbohydrate fuel exhaustion. Carbohydrates have been gaining in popularity with runners over the past several years, but it seems clear that the average runner still doesn't know what energy nutrition is all about. In fact, from a review of recent literature on running, it appears that many of those who are advising runners on the subject don't really understand it themselves

The idea that an athlete's diet can influence physical endurance is not recent. Experiments by Danish scientists in 1932 demonstrated that subject athletes on a high-fat diet became exhausted after 90 minutes of stationary cycling, but could endure for more than four hours at the same work load when their diets were high in carbohydrates. More recent work has shown that the primary effect of the diet is on the storage capacity of the muscles for carbohydrate fuel (glycogen), and on the rate at which these glycogen stores are deposited. At this point, I should repeat what I said last month about the practice of "carbohydrate depletion and loading." The subject matter I will be discussing here has nothing whatsoever to do with this practice. I disapprove of it and recommend strongly against its use.

In fact, bizarre dietary and training practices are not required to enhance the fuel storage capacity of the muscles. An ongoing high-carbohydrate diet will promote a steady-state maximum level of muscle glycogen storage which is at least 50% greater than the normal maximum attainable on a typical mixed diet. In addition, the time required after exercise for the body to completely restore muscle glycogen to maximum capacity can be cut in half on a high-carbohydrate diet.

Let's look at dietary planning for long-distance runners and see what it means to follow a diet that is "high-carbohydrate." The typical American today obtains about 14% of his calories from protein, 44% from fat, and 42% from carbohydrate. This proportion of carbohydrate (42%) is not very high and will not promote a highly efficient recovery of muscle glycogen stores. To find out how high a proportion of dietary carbohydrate is possible, let's see how much of the other two calorie contributors, fat and protein, are required to maintain good health and peak physical condition.

The Recommended Dietary Allowance (RDA) of protein for those over 17 years of age is 0.3 grams per kilogram (2.2 lbs.) of body weight per day. Thus, for a 154 lb. runner, 56 grams of protein is recommended. In a 3,000 calorie per day diet, this amount of protein would account for only 7% of the total daily calories. The RDA for protein does not change with an increase in physical activity.

Very little fat is required in the diet to assure the normal functioning of the human body. Certain fatty acids are essential for normal metabolism and can only be obtained in sources of dietary fat, but the total requirement for them is very small—perhaps 3% of the total calorie intake. The only other essential role for dietary fat is as a carrier for the fat-soluble vitamins, but this function is also served by a minimum intake of fat in the diet. Recently, I have heard expressions of concern by runners, suggesting the possibility of essential fatty acid deficiency on low-fat diets. I find it difficult to conceive of an ongoing runner's diet that would be so devoid of dietary fat that such nutritional deficiency would be a problem. But, I have a much more compelling reason for recommending greater-than-minimum amounts of fat in the diets of runners and other athletes—they don't like minimum-fat diets and won't follow them.

It is probably possible for a runner to maintain good health and peak condition on a regular diet containing 85% of the calories as carbohydrate. However, fat and protein add palatability that few people are willing to do without. Therefore, I usually recommend diets containing 60-70% carbohydrate, 10-15% protein and 20-25% fat.

One important question remains--what are carbohydrates? This is not nearly as simple a question as it may seem to be. You are probably aware that the dietary carbohydrates are represented by starch and simple sugars and are abundant in such foods as the cereal grains, starchy vegetables, fruits and sweets. But not all dietary carbohydrates are the same. In some respects, the body deals with different kinds of carbohydrates as though they were completely different substances. To understand endurance nutrition, we must be able to distinguish the important differences that exist among carbohydrates and carbohydrate-containing foods.

Every carbohydrate contains a simple sugar as its basic unit of structure. When a dietary carbohydrate is digested, these sugar units are released and assimilated into the blood, becoming blood sugar. In the normal individual, every significant increase in blood sugar is accompanied by a release of insulin, the hormone which mediates the distribution and disposal of the sugar in the body. In general, the more rapid the increase in blood sugar, the greater the insulin response. And, the greater the insulin response, the more rapidly the sugar is removed from the blood.

How the blood sugar will be used in the body is largely dependent on the rate at which the sugar units are removed from the blood. If they are eliminated very rapidly, significant proportions of them will be made into fat. On the other hand, the formation of muscle glycogen is a slow and low-priority process, which is most efficient when blood sugar disposal occurs more slowly.

Imagine yourself working at the end of a conveyor belt, which is delivering pies for you to remove to packing cartons. As long as the conveyor moves slowly, you will be able to handle all of the pies it delivers. However, if the conveyor moves too fast for you, many of the pies will fall on the floor and will be thrown in the garbage. Similarly, if the digestive system (the conveyor) delivers blood sugar (pies) slowly, much of it will be used by the body for essential purposes, including the formation of muscle glycogen. If the blood sugar is formed too rapidly, it is converted to fat (thrown in the garbage)

To allow efficient use of the carbohydrates you eat for the formation of muscle fuel reserves, you should eat in such a way that your blood sugar responses favor the slow and deliberate utilization of the sugar units. This will only occur if the uptake of the sugar from the digestive system is also slow and deliberate. Thus, to promote maximum daily restoration of muscle glycogen stores, it is essential not only to eat a high proportion but those carbohydrates must be of a type to promote slow assimilation of their constituent sugar sub-units.

In general, the most structurally complex carbohydrates are the most slowly digested and assimilated. Common examples are whole grains and raw, or lightly cooked, vegetables. On the other hand, carbohydrate foods which contain large proportions of free, insulin-stimulating sugars will be the most rapidly absorbed and will set the conveyor going at its fastest rate. Common examples of these foods are desserts, candy, sugar-sweetened soft drinks and some fruits, notably pineapple. Although it is a bit of an exaggeration, I consider the consumption of soda pop the rough physiological equivalent of drinking salad oil. Both contribute generously to the body's stores of fat.

Runners interested in maximum endurance should eat at least 60% of their calories as carbohydrates, and the majority of these carbohydrates should be of the structurally complex type. Next month we'll take a closer look at the relative values of specific foods as sources of fuel for runners, and we'll put together some sample menus to illustrate the practical application of high-endurance dieting.