A revolutionary new way to slam 20 per cent more glycogen into your muscles.

It used to be so simple. You completed an exhaustive workout and then ate minimal amounts of carbohydrate for three or four days to wipe out your muscle-glycogen stores. Then came the good part: you trained lightly and consumed biscuits, pies, pasta, and potatoes in lavish quantities for three days to super-saturate your leg muscles with carbohydrate. This was the classic 'carbo-loading' strategy developed by top-level Swedish scientists in the late-l960s and early 1970s, a plan which was used by countless endurance cyclists, cross-country skiers, and runners prior to their long-distance races.

But then Dave Costill made things simpler still. In his lab at Ball State University, Costill showed that the initial, three- to four-day, low-carbohydrate, 'depletion' stage was impractical and unnecessary. The famed Indiana scientist suggested that endurance athletes could stay on top of the carbohydrate game simply by reducing their training and eating increased amounts of carbohydrate during the three days before an important, long-distance competition.

The two-hour 'window'

It would have been nice if things stayed that uncomplicated, but scientists gradually discovered that many endurance athletes were not storing enough glycogen in their muscles during periods of vigorous training and were consequently having trouble maintaining their desired training loads. In the late 1980s, one reason for this lack of glycogen storage became apparent: research showed that muscle cells are quite temperamental about when they like to sock away glycogen. For example, muscle fibers usually have little inclination to store glycogen before a meal or during sleep, but they are most willing to pull carbohydrate out of the blood and stockpile it during a fairly brief period - the two hours immediately after a strenuous workout. It seemed that many glycogen-deficient athletes were failing to give their muscles what they needed during this critical two-hour time span.

As a result of that discovery, wise athletes began to 'fuel up' with copious quantities of sports beverages and high-carbohydrate foods, taken in shortly after their workouts had ended. The next step was to figure out exactly how much carbohydrate was actually needed during this 'muscle prime-time' (the two hours after a workout), so that glycogen would be replaced as quickly as possible.

Fortunately, in about 1987 John Ivy, Ph.D. and his colleagues at the University of Texas discovered that eating about two-thirds of a gram of carbohydrate per pound of body weight, once right after a hard workout and a second time two hours later, helped athletes achieve super-high muscle glycogen levels in a short period of time. If you weighed 150 pounds, all you had to do to ensure that the interiors of your muscle cells were 'carbohydrate pantries' was to consume 100 grams of carbohydrate (150 X 2/3) right after your workout and 100 grams two hours later. If your regular meals were also biased toward carbohydrate, you could be fairly certain that your muscle cells would contain enough glycogen to keep you training at a high level.

Supplanting the Ivy

But it's a changing world, and the Ivy strategy now seems almost as outdated as the old Swedish carbo-loading regimen. In recent research at Ohio State University, scientists have uncovered a scheme which quickly gets at least 20-per cent more carbohydrate into your muscles, compared to the Ivy plan. This 20-per cent boost in carbohydrate

should help to ensure greater endurance during subsequent long workouts or races. To put it simply, you'll have a much lower risk of having your performances harmed by low muscle-glycogen levels.

In the new Ohio State investigations, 10 fairly fit individuals cycled for 75 minutes at an intensity of 70% V02max (80 per cent of maximal heart rate) and then surged through five one-minute sprints at 100% V02max (very close to maximal heart rate). To further reduce muscle-glycogen levels, the subjects then completed 10 sets of 10 leg extensions or flexions on a Cybex resistance-training machine.

48 hours after this rugged session, the athletes returned to the laboratory and repeated their cycling efforts (75 minutes of riding, plus five one-minute sprints). Following each of the two workouts, the 10 participants consumed carbohydrate every 15 minutes for four hours. The actual amount of carbohydrate was huge - a total of almost three grams of carbohydrate per pound of body weight, subdivided into sixteen equal doses over the four-hour period. This meant that the Ohio State athletes ingested about 30 grams of carbohydrate every 15 minutes.

Although stoking in that much carbohydrate required real effort, the strategy paid off: muscle biopsies revealed that the rate of glycogen storage was at least 20-percent greater than the storage rate achieved with the old, 'two-snacks-in-two-hours' program and up to 90-per cent greater than traditional carbo-replacement plans.

The reason for the exceptionally advanced glycogen storage in the Ohio State study was simply that the carbohydrate was ingested in 15-minute intervals over four hours, not just in one or two lump sums. The 1 5-minute pattern insured that blood glucose and insulin levels stayed exceptionally high throughout the entire four hours after exercise. In fact, insulin, a potent booster of glycogen storage, actually increased steadily over the four-hour time period!

An insulin digression

Before going further with this story, we should note that insulin has attracted a bit of notoriety recently. Specifically, ads for various nutritional products sold to athletes suggest that insulin is 'bad' because it reduces the use of fat for energy. While it' s true that insulin blocks the release of fat into the blood from fat cells, and it's also true that this would be a bad deal for you if you were running long distances without being able ingest a sports drink, it's also important to point out that insulin is a critically important hormone which aggrandizes your muscles' stores of carbohydrate. This surplus carbohydrate then allows you to more effectively carry out high-quality interval workouts, long-distance training sessions, and races lasting an hour or more. The bottom line is that you want to have increased blood-insulin levels after a meal (or series of snacks), so that you can stuff as much energy as possible inside your muscle fibers.

The new, four-hour strategy is particularly important if you work out more than once a day, if you're a very high-mileage trainer, or if you complete a lot of intense intervals, since these scenarios extensively deplete muscle glycogen. The strategy may also be of value if you're a athlete who carries out a lot of training on hilly terrain, because the Ohio State researchers showed that glycogen storage was reduced by 20 per cent when the post-cycling weight-training work was eccentric in nature. Since hill running emphasizes eccentric muscle contractions (actions in which muscles are stretched as they are trying to shorten), normal glycogen storage patterns may be compromised during hill training. Fortunately, the Ohio State strategy is a way to perk up muscle-carbohydrate attendance in athletes who train on rolling terrain.

Wolfing down large amounts of carbohydrate after a workout may seem a bit extreme, but it's a strategy routinely followed by some of the most successful endurance runners in the world - the elite Kenyans. At their rugged, high-altitude camp near Embu, Kenya, where the Kenyan cross country teams complete three demanding workouts per day and run about 140 miles per week, the Kenyans guzzle highly sugared cups of tea and milk almost immediately after each training session and then devour huge platefuls of high-carbohydrate food. They do a great job of preparing their muscles for their next workout, which may follow the preceding training session by just four to six hours. However, even the world-beating Kenyans don't have the formula exactly right. The Ohio State idea is to 'graze' for four hours or so, converting your bloodstream into a steady river of carbohydrate and insulin and forcing your muscles to work overtime stacking up that carbohydrate as glycogen.

Tips for maximum glycogen storage

If you usually run, cycle, swim, or work out on a stair machine at a moderate intensity for less than about 50 minutes at a time, don't worry too much about the new carbo-loading scheme unless you train more than once a day or tend to eat too little carbohydrate. However, interval and repetition workouts can dramatically deplete glycogen, even when they last less than 50 minutes, so do consider using the strategy after high-intensity sessions, especially if you plan to cycle or go for a long, steady run later in the day.

During all periods of very heavy training and whenever you are significantly increasing your workout duration or total training volume, give the new carbo-loading scheme a try. Also employ the strategy during times when extensive hill training is a priority.

It's easy to figure out how to carbo-load using the Ohio State pattern. Simply multiply your weight in pounds by three. Divide the result by 16 to determine the number of grams of carbohydrate to eat every 15 minutes. Example: Penny weighs 117 pounds. 117 X 3 = 351. 351/16 = 22. 22 grams of carbohydrate should be ingested every 15 minutes.

Since you usually don't think about how many grams of carbohydrate you're actually ingesting, we've made things easier for you by listing food servings which provide about 20-25 grams of carbohydrate:

(1) Two cups of skim milk
(2) A little more than half a bagel
(3) A two-thirds cup serving of cooked pasta
(4) An apple or a banana or a pear
(5) Four dates
(6) A cup of orange juice
(7) One-fifth of a cup of raisins (or two half-ounce packets)
(8) An ounce and one-half of corn chips
(9) A medium baked potato
(10) A slice and a quarter of most breads
(11) Two slices of non-fat 'diet' bread
(12) A cupcake
(13) An English muffin
(14) A cup of oatmeal
(15) One and one-half cups of Special K cereal
(16) One-half cup of cooked rice
(17) Three carrots

(18) Two-thirds of a cup of cooked lentils
(19) A half-cup of cooked kidney or pinto beans
(20) A cup of split pea or bean soup

If ingesting 20-25 grams of carbohydrate every 15 minutes for four hours after a tough workout is just too much of a bother, a modified glycogen-storage plan may work almost as well. According to Mike Sherman, Ph.D., one of the Ohio State investigators and an internationally acclaimed expert concerning carbohydrate's role during exercise, taking in 40-50 grams every 30 minutes or 60-75 grams every 45 minutes might yield similar rates of carbohydrate warehousing.

The new carbo-loading scheme requires some planning, and you'll still want to eat some additional carbohydrates during your regular meals, but the effort should add fire to your training and competitive efforts. With extra carbohydrate in your muscles, you'll simply be able to train or compete at a fast pace for longer periods of time.

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