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Swallow This

By GRETCHEN REYNOLDS

From the perspective of an athlete, few things top the virtuous satisfaction that comes from a hard workout. That 10-mile run, that 1,500-meter pool sprint, that hour with the free weights. Makes you feel great, right? You'll do it again tomorrow, for sure. But then it hits — the aftermath.

Within a few hours, your muscles begin sending vicious little reminders about your impressive efforts. Delayed-onset muscle soreness, as it's called, settles in roughly 12 to 24 hours after an intense bout of training, especially if it involved unfamiliar or extreme movements. The affected muscles become so tender and strained that the process of rising from bed the next morning becomes a challenge.

Even if you haven't arrived at this sorry state, repeated hard workouts can tax the body in insidious ways. Muscles, over the course of an hour or so of serious work, use up most of their stored energy. Without remediation, those muscles won't respond as well during your next workout. They'll be more prone to injury. You'll be slower. The 70-year-old from down the street will pass you on the running path.

Completing a hard workout, then, is just the first step. You also have to undo all the damage you've just done.

Start with your postworkout meal. The regeneration of your muscles begins, improbably as it may seem, with that. "Back in the early '90s, most athletes, especially runners and cyclists, were preoccupied with [carbohydrates](#)," says John Ivy, the chairman of the department of kinesiology and health education at the [University of Texas](#) in Austin and one of the pioneers of research into exercise recovery. This was in the heyday of carbo-loading, when athletes were convinced that the more pasta and bread they ate before a hard workout, the more stored energy they'd have.

But carbo-loading in advance of exercise is not the most efficient way to stock muscles with fuel, physiologists now know, thanks in large part to research conducted by Ivy. When

reviewing studies of diabetics, he became intrigued by similarities with his own tests on cyclists: for both groups, insulin in the blood was more effective at carrying energy into the muscles if those muscles had recently been active. “Exercise makes your muscles more responsive to insulin, and this insulin, in turn, increases glycogen muscle uptake,” he says. In other words, exercise prompts your muscles to absorb more fuel — glucose, which is stored as glycogen — from the bloodstream. (Carbo-loading can’t take advantage of this insulin response because it precedes, rather than follows, a workout.) Your body is actually primed by the exercise to help itself replenish lost fuel.

This improved insulin response, however, lasts only for a brief time after a workout. “You have a window of about 30 to 45 minutes,” Ivy says. After that, muscles become resistant to insulin and much less able to absorb glucose. Drinking or eating carbohydrates immediately after a strenuous workout, at a level of at least one gram per kilogram of body weight, is therefore essential to restoring the glycogen you’ve burned. Wait even a few hours and your ability to replenish that fuel drops by half.

It’s also crucial that you take in some protein. Though it poses challenges to strict [vegetarians](#), the latest research shows quite definitively that protein spurs even more of an insulin response than do exercise and carbohydrates alone. “Protein co-ingestion can accelerate muscle glycogen repletion by stimulating endogenous insulin release,” says Luc van Loon, an associate professor of human movement sciences at Maastricht University in the Netherlands and the author of several important studies about recovery. Translation: coupling protein with carbohydrates prompts your muscles to store even more glycogen for use during your next workout.

“I’d advise people to have their recovery drink ready and waiting for them before they leave on a run or long bike ride,” Ivy says. Ivy himself often drinks low-fat chocolate milk, but any food or drink that includes both carbohydrates and protein — a recovery drink, a smoothie, yogurt — will work.

Then have a real meal within two hours. “You can maintain increased insulin levels and accelerated rates of recovery for about four to six hours if you continue eating,” Ivy says. Of course, you can also get by without such [diet](#) timing. “But you won’t recover as well,” Ivy continues. “You probably won’t be able to work out as hard on a daily basis.” The old guy who chugs his milk and Hershey’s syrup will not only pass you — he’ll lap you.

Meanwhile, there’s the physical damage inside your muscles to consider. Skeletal muscle is a unique kind of tissue, made up of long, thin fibers composed of several different proteins. These proteins interlock like Legos inside fibrous compartments called sarcomeres.

Sarcomeres can stretch, but only so far.

During certain kinds of movements, some sarcomeres are pulled past their tolerance. The proteins inside separate, resulting in micro-tears throughout your muscle tissue. After a few hours, this leads to inflammation, [swelling](#), stiffness and pain. (Eccentric muscle contractions, which lengthen muscles, are the main culprit in delayed-onset muscle soreness. Concentric contractions, in which muscles shorten — the upward motion of a biceps curl, for instance — cause less damage. That’s why running downhill makes you more sore the next day than running on flat ground.)

“This soreness is actually a good thing,” says Thomas Swensen, a professor of exercise and sports science at Ithaca College in Ithaca, N.Y., and a leading researcher into exercise recovery. “You want to stress the muscles. They will adapt positively.” The muscles will rebuild themselves, becoming stronger and more pliable. “That’s the whole point of hard training,” he says. “But it’s only effective if you recover fully.”

Which is another reason it’s important to up your protein intake after a workout; that same protein will also help speed muscle repair. “Exercise stimulates muscle protein synthesis and protein breakdown,” van Loon says. “However, without protein or amino acid ingestion, the net balance between protein synthesis and breakdown will remain negative” — i.e., your workouts, in the long run, may do your muscles more harm than good. But eat enough protein immediately after exercising and your muscles will repair themselves fully and become stronger.

Other postworkout recovery strategies, including many that athletes swear by, have far less scientific backing. Take massage. A 2000 study of British boxers showed that postworkout massage made the athletes only feel as if they were recovering quickly; they did not perform any better than those not massaged. Swensen’s own 2003 study of massage and recovery produced similar results as the British research.

These studies, however, like many others that have examined massage and exercise, were small and short-term. “It’s possible that if you followed athletes over the course of several months,” Swensen says, “you might see some benefits from massage. Those studies haven’t been done.”

Similar ambiguity clouds the use of ibuprofen after exercise. Although advertised as an anti-inflammatory, ibuprofen doesn’t always work as expected. A 2006 study of the drug’s use among ultra-marathoners found that it did not lessen muscle damage or soreness or reduce inflammation. And although most users do not experience side effects, ibuprofen has been associated with [kidney damage](#) and [gastrointestinal bleeding](#).

Finally, there are ice and heat. Many elite athletes swear by a limb-numbing ice bath, and others prefer a soak in a hot tub — although little scientific evidence supports either remedy. Ice will effectively block the swelling associated with a serious injury, such as a sprain, but has not been proven to speed the healing of muscle tissue stressed by a workout. In a study published last year in the *British Journal of Sports Medicine*, people treated with ice after strenuous exercise later reported more pain upon standing than people immersed in tepid water. The study's authors bluntly concluded that their research “challenges the wide use of [icing] as a recovery strategy by athletes.” Similarly, a study published in March in the *European Journal of Applied Physiology* found that, when it came to muscle recovery, a hot bath was little better than merely sitting quietly for a while.

So where does that leave you, the athlete who has just worked out so diligently? Mixing a smoothie or glass of chocolate milk, the one recovery strategy that satisfies both your inner physiologist and inner child. .

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