

Even My Eyebrows Hurt!

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Just about everyone who strives to be the best they can be develops sore muscles at some time, so it is amazing that this is still mostly a mystery. Consider this: we don't really understand the main source of pain, we don't understand why it takes so long to show up, most of the treatments suggested don't work consistently, and there is no reliable way to prevent the problem except taking it easy.

If you overdo any kind of physical effort... working out longer than usual or harder than usual... about 12 to 48 hours later you will develop very stiff, sore muscles. In the sports medicine community, this is called **delayed onset muscle soreness**, known as DOMS for short. Those of us who taper for the big meets, swimming faster than usual, can attest to the fact that everything hurts... even the eyebrows. This can bring on a disconcerting feeling of "I'm in trouble; I don't feel good even in the taper; how can I ever do well at the meet?!" This seems to be the price we pay for swimming fast; but pain is still a signal that something is wrong, so let's see what you can do to minimize the problem.

Muscle Damage and Soreness

Hard exercise causes muscle damage. In fact, this is the principle you have to follow to increase muscle size. "Muscle damage must precede size increases. The repair process causes increased muscle size," says William Evans, Ph.D., at Penn State University. If you looked under a microscope at your sore muscles after a hard or fast workout, you would see torn and ruptured individual muscle cells, and breakdown of the membranes between them. There are some components of cells that are too large to escape from normal cells, but when cells are beaten up and have broken membranes, the large molecules escape and end up in your bloodstream. This is useful to researchers, because they can study muscle damage by taking blood samples rather than muscle biopsies. An enzyme called creatine kinase (**CK**) is an example, which is often used as an index of muscle damage. Another enzyme called lactate dehydrogenase is an example of a molecule that comes from the breakdown of the lipid cell membranes themselves, and it also leaves its "footprints" in the blood. Concentrations of these "escaped" enzymes are seen to rise as high as two to 10 times normal in the blood depending upon type, duration, and intensity of training bouts.

Muscle cell damage not only leaves you stiff and sore, you also lose some muscle strength; you won't be able to move as well as normal, and you may have swelling. The kind of exercise you perform can affect how you feel. Sometimes your muscles stretch and return to their original size; this is called eccentric exercise. **(If the muscle has not been pre-stretched before use, the limited range-of-motion (ROM) will allow for eccentric activity to predominate.)** Other times your muscles contract and return to their original size: this is called concentric exercise. **(Here, pre-stretching will prevent muscle tearing as the muscle tries to move through its accustomed range-of-motion.)** Lifting weights in an arm-curl is concentric; letting the weight down to lengthen the arm is eccentric.

Almost all current theories acknowledge that eccentric action is the primary initiator of muscle soreness. Many studies over the years have compared concentric, eccentric, and static muscle actions, with those performing eccentric activity having, by far, the most muscle soreness. A rather clear-cut study was undertaken in the 1980's having test subjects run on a treadmill for 45 minutes on two separate days. Initially, they would run on a level grade. Another day they would run on a 10% downhill grade. No muscle required extensive eccentric action, resulted in considerable soreness within 24 to 48 hours, even though the blood lactate levels, previously thought to cause muscle soreness, were much higher with level running.

High-intensity, speed workouts can also affect how you feel. Muscles become sore after faster movement, even if the force and work levels were higher at slower speeds, according to studies from East Carolina University and the University of Wyoming. Sometimes you may hear that protein loss is a factor in sore muscles, but this is not the case. It is true that exercise increases protein turnover because some is broken down and is replaced during repair, but the amount is much less than most would believe. Most Americans get about 15% of their total calories from protein,

which is about twice the recommended dietary allowance. Generally, they don't need extra in their diet, or protein, or amino acid supplements for that matter. But those engaged in high-intensity, strength-demanding athletic endeavors, probably do need more protein than the average. As much as one gram of protein per pound of body of weight might be needed to build and sustain muscles and the power they generate.

Preventing DOMS is Tough

Researchers have worked hard to try to prevent muscle soreness, but usually their ideas haven't worked. For example, when you work out, you breathe faster because you need more oxygen to burn muscle fuel faster. Some of the extra oxygen causes an increase in reactions that produce free radicals which can cause damage even with anti-oxidant vitamins, but they don't reduce muscle soreness. Vitamins C and E and Beta-Carotene made no difference to the after-effects of intense training of a rower at Cal Berkeley.

There are similarities between sore muscles and inflammation, which causes pain, redness, stiffness, and swelling. It would sound logical to use anti-inflammatories in this situation; the results have been very inconsistent; sometimes they seem to help, but more often they do not. Topical products that contain counter-irritants, such as menthol, seem to stimulate blood flow. Other topicals contain anti-inflammatories such as trolamine salicylate, a relative of aspirin. Both kinds of products may help a little by making you "feel" better with a counter-irritant effect, but there is no evidence that they actually promote healing. Cold applications also provide no actual healing but may keep swelling and in-sight bleeding down to a minimum immediately after activity; this could indirectly help the situation. But muscle spasm and contraction can result from intense cold, so cold (**cryo**) therapy should be limited to short-term immediate after-use application. On the other hand, adding heat such as with a heating pad (**moist heat being better than dry heat**) some hours later does provide for muscle-relaxation and increased blood flow, allowing for accelerated muscle repair.

Minimizing DOMS

Good training habits help. First, start with a slow warm-up. Cold muscles suddenly put to work are more likely to become damaged than warmed-up ones. Also, warm-ups help you relax, and put you in a right frame of mind to tackle a challenging workout. Warm-ups gradually increase your heart and breathing rates, and increase the flow of oxygen and nutrients to your muscles before you begin to work them hard. They also allow a gradual increase in the speed and strength of muscle contractions, and a decrease in joint stiffness. About 15 minutes should be allotted to each workout for this most important of rituals. Ideally, holding the stretch for about 30 seconds. This overcomes the body's resistance to stretching and allows for the muscle's full-range-of-motion.

Wise athletes cool down after workouts or races. If you suddenly quit, your heart and breathing rates will soon go back to resting levels, but your muscles retain by-products such as lactate. If you continue to exercise at a lower intensity (**about 60% of maximum effort**), you keep your heart pumping at a somewhat higher than resting level. This keeps the supply of nutrients coming to help clear out your muscles.

The main causes of DOMS are sudden increases in intensity or duration of workouts, or hard races. Large forces intensely-applied to the relatively small cross-sectional area of a muscle produced cell-membrane rupture, leakage of calcium and eventually necrosis (**cell death**) that peaks about 48 hours after the exercise. To build a training program logically, keep your training intensity and duration during the same week. These guidelines will allow your body to recover properly, and adapt slowly to improve performance levels. The military, on the other hand, is not famous for its logic and chooses to condition its recruits with just the opposite tactic: intense exercise every day with the expectation that eventually pain and stiffness will dissipate.

You cannot over-emphasize the importance of adequate recovery from one workout before you begin your next; following hard workouts with easier ones is one way to implement this. And remember to eat a high-carbohydrate, low fat diet so your muscles have plenty of fuel.

Handling Sore Muscles

If you follow the ground rules but end up sore anyway, what then? Conventional injury treatments don't seem to work well for DOMS, and there is now some evidence that the anti-inflammatories (Motrin, Aleve, etc.) may actually retard healing due to their prostaglandin inhibition (prostaglandins allow the body to trigger natural responses to infection and injury). Relief provided by these medicines seems to come mainly from their analgesic (pain-relieving) properties and from reducing the attendant swelling surrounding the inflamed area.

You can try massage; most who do find it makes them feel good, even though it hasn't been proven to speed healing. A series of tests have shown that when athletes worked out hard and followed up two hours later with 30 minutes of massage, their blood CK levels were lower, a kind of white blood cell called neutrophils that helps fight inflammation increased, and the athletes reported lower levels of DOMS, compared to a placebo treatment with "medication." You can expect best results from a certified massage therapist, but self-massage and the use of hand-held massagers are also good.

Small amounts of moderate exercise (active recovery) are much better than inactivity (passive recovery). You want to give your body a prod to stimulate natural healing processes, but not enough to cause more damage. Usually, one recovers in a few days from intense activity and is the better for it. Hard races need more caution, but in a multi-day championship, recovery must be timed to allow for repeat competition. A prescribed warm-down after each swim would be the most beneficial, along with massage at the end of the day's events.

There is one more area of thought that I want to present even though to traditionalists it may seem a bit of a "stretch" (pun intended) in physiologic reasoning: the eating of certain fruits which contain enzymes that reduce edema (swelling) and inflammation and break up dead and damaged tissue to help heal and repair muscles sooner for the next bout of exercise. Pineapples contain bromelains; papaya, mangos, and passion fruit contain papain and papain. These fruits (must be fresh, not processed) eaten daily can provide that little bit of added help in allowing the body to recover faster. In fact, for the 2000 Olympic Games in Sydney, the coaches of the German National Team have mandated the eating of such fruits to allow their athletes to train and race harder and then aid them in the recovery process. They are also using a product called Wobenzym N which contains the enzymes pancreatin, papain, bromelain, trypsin and chymotrypsin plus the antioxidant rutin in the hopes of ensuring that all the athletes get the necessary quantities of these reparative enzymes.

Ask anyone who has weathered the multi-swim battles at zones or nationals. They are usually so beat-up that **even their eyebrows hurt!**●