

# Feel the Burn: Where that pain in your muscles come from

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Oh my god. If I hear one more person say, “Oh my god I’m so sore from all this lactic acid in my muscles” I’m going to ... Ok, well I’m not really going to do anything, but please stop saying that. I’m around enough runners, ultimate frisbee players and yoga enthusiasts to hear something along those lines quite frequently.

Sorry for the outburst, but I just get all worked up when people understand the science just enough to get it completely wrong. To explain: you are not sore because of lactic acid built up in your muscles, so stop complaining about it. You are sore because of muscle damage and the resulting chemical cascade, which increases the activity in pain nerve cells.

“If the lactic acid thing is wrong” you might ask yourself, “then why does everyone say it.” Well it’s based on a series of facts and an incorrect assumption. Here are the facts:

Fact 1: Heavy exertion of the muscles causes lactic acid build up

Fact 2: Lactic acid build up in your muscles is accompanied by pain.

Fact 3: Your muscles hurt for a few days after a heavy workout.

So all those things are true. But unfortunately it is not the lactic acid that causes the soreness. By the time you’re complaining of soreness the next day or two, the lactic acid is long gone from your muscles.

To understand everyone’s misunderstanding you need to know where lactic acid comes from, and it has to do with how your body makes energy (aka ATP. If that rings a bell, then kudos for paying attention in high school biology). Under normal circumstances your body turns sugar into energy using oxygen in the process (that’s why you need to breathe). This series of chemical reactions is called aerobic respiration. However, when your muscles are working extremely hard they can’t get enough oxygen to carry out aerobic respiration. For example, walking up ten flights of stairs or doing ten pushups (or, for some people, one pushup). Fortunately your body can turn sugar into energy without oxygen. This process is called anaerobic respiration, and unfortunately it produces lactic acid as a chemical by-product. In addition, anaerobic respiration increases the acidity of your muscles (other acids in addition to lactic acid). The increased acidity in your muscles activates pain nerve cells called nociceptors. The nociceptors send the signal all the way to your brain to let you know about it.

That is why when the elevator’s broken and you have to take the stairs, or you’re carrying heavy groceries all the way across the parking lot, you start to feel the burn (or during spinning or yoga). That feeling is the burn of acid in your muscles where lactic acid is building up. Your nociceptors sense it in the same way that nociceptors in your tongue let you know when you bite into a jalapeño.

In those cases you’re working so hard that your body can’t physically get enough oxygen to those muscles. But (and this is a big but), as soon as you stop using those muscles so intensely then your body can provide enough oxygen. Within a few minutes all that lactic acid, and the other acids, are

gone.

So why do your muscles hurt the next day? Muscles hurt because when you work out really hard you cause micro-damage to the muscle tissue (and sometimes also to the joints). The damaged tissue causes an inflammatory chemical response. This involves the release of several chemicals in the area including histamine, bradykinin and substance P (no my dear readers with 3rd grade minds, substance P is not the same as substance Pee).

Substance P increases the size of the blood vessels in the area (i.e. vasodilation). Histamine also increases vasodilation, and in addition makes your capillaries leakier (N.B. histamine also makes your capillaries leakier in allergic reactions, which is why your eyes water and your nose runs). The combination of vasodilation and increased leakiness means that fluid begins to accumulate in the damaged area, and your muscles get swollen.

But swelling is not the only thing these chemicals do. They also cause a sensitization of nociceptors. If you're confused about what nociceptors do, I'll just say briefly that there are different kinds that sense different kinds of pain. While some nociceptors let you know when there's a lot of acid building up, others let you know when there's a lot of physical pressure pushing against them. Usually these pressure sensitive nociceptors don't send a pain signal up to the brain unless there's really a lot of pressure. For example, pushing on someone's arm might not activate nociceptors, but punching them sure does. However, once the nociceptors get sensitized by substance P and histamine then just a normal touch can cause a burst of pain signals. Not only are they sensitized to external touch, all that swelling squeezes the nociceptors even more, so just moving your muscles causes bursts of pain signals.

So what can you do with this information? Well after a really hard workout you should treat your muscles like they're injured. Rest, ice, compress, elevate (RICE). Rest means you don't cause further damage while your muscles are healing. Ice makes the blood vessels smaller so they stop leaking fluid. Elevating and compressing move fluid out of the area so that your muscles don't get so swollen. That extra fluid and all the chemicals in it get absorbed back into the blood stream so they stop making your muscles hurt.

I hope this was a useful public service announcement. I know I will be happier when people stop complaining about lactic acid, and start complaining about "all the extra fluid in my muscles" and how "these damn histamines are sensitizing my nociceptors." Now get up off your butt and go lift some weights or something. Feel the burn baby!

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