

Why does lactic acid build up in muscles? And why does it cause soreness?

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Stephen M. Roth, a professor in the department of kinesiology at the University of Maryland, explains.

As our bodies perform strenuous exercise, we begin to breathe faster as we attempt to shuttle more oxygen to our working muscles. The body prefers to generate most of its energy using aerobic methods, meaning with oxygen. Some circumstances, however, --such as evading the historical saber tooth tiger or lifting heavy weights-- require energy production faster than our bodies can adequately deliver oxygen. In those cases, the working muscles generate energy anaerobically. This energy comes from glucose through a process called glycolysis, in which glucose is broken down or metabolized into a substance called pyruvate through a series of steps. When the body has plenty of oxygen, pyruvate is shuttled to an aerobic pathway to be further broken down for more energy. But when oxygen is limited, the body temporarily converts pyruvate into a substance called lactate, which allows glucose breakdown--and thus energy production--to continue. The working muscle cells can continue this type of anaerobic energy production at high rates for one to three minutes, during which time lactate can accumulate to high levels.

A side effect of high lactate levels is an increase in the acidity of the muscle cells, along with disruptions of other metabolites. The same metabolic pathways that permit the breakdown of glucose to energy perform poorly in this acidic environment. On the surface, it seems counterproductive that a working muscle would produce something that would slow its capacity for more work. In reality, this is a natural defense mechanism for the body; it prevents permanent damage during extreme exertion by slowing the key systems needed to maintain muscle contraction. Once the body slows down, oxygen becomes available and lactate reverts back to pyruvate, allowing continued aerobic metabolism and energy for the body's recovery from the strenuous event.

Contrary to popular opinion, lactate or, as it is often called, lactic acid buildup is not responsible for the muscle soreness felt in the days following strenuous exercise. Rather, the production of lactate and other metabolites during extreme exertion results in the burning sensation often felt in active muscles, though which exact metabolites are involved remains unclear. This often painful sensation also gets us to stop overworking the

body, thus forcing a recovery period in which the body clears the lactate and other metabolites. Researchers who have examined lactate levels right after exercise found little correlation with the level of muscle soreness felt a few days later. This delayed-onset muscle soreness, or DOMS as it is called by exercise physiologists, is characterized by sometimes severe muscle tenderness as well as loss of strength and range of motion, usually reaching a peak 24 to 72 hours after the extreme exercise event.

Though the precise cause of DOMS is still unknown, most research points to actual muscle cell damage and an elevated release of various metabolites into the tissue surrounding the muscle cells. These responses to extreme exercise result in an inflammatory-repair response, leading to swelling and soreness that peaks a day or two after the event and resolves a few days later, depending on the severity of the damage. In fact, the type of muscle contraction appears to be a key factor in the development of DOMS. When a muscle lengthens against a load--imagine your flexed arms attempting to catch a thousand pound weight--the muscle contraction is said to be eccentric. In other words, the muscle is actively contracting, attempting to shorten its length, but it is failing. These eccentric contractions have been shown to result in more muscle cell damage than is seen with typical concentric contractions, in which a muscle successfully shortens during contraction against a load. Thus, exercises that involve many eccentric contractions, such as downhill running, will result in the most severe DOMS, even without any noticeable burning sensations in the muscles during the event.

Given that delayed-onset muscle soreness in response to extreme exercise is so common, exercise physiologists are actively researching the potential role for anti-inflammatory drugs and other supplements in the prevention and treatment of such muscle soreness, but no conclusive recommendations are currently available. Although anti-inflammatory drugs do appear to reduce the muscle soreness--a good thing--they may slow the ability of the muscle to repair the damage, which may have negative consequences for muscle function in the weeks following the strenuous event.