Lactate and Lactic Acid -- Are We Listening to Exercise Science?

By Dario Fredrick

[Velo News, Vol. 33/No. 8, May 31, 2004]

One of the biggest challenges that a cycling coach faces is to explain exercise physiology in an easy to understand way. Unfortunately, the oversimplification of scientific concepts often leads to a misunderstanding of what's really happening in the body. For many years, some of the biggest misconceptions were about lactate and lactic acid. Despite popular belief, lactate accumulation does not cause fatigue. So, what does exercise science really tell us about lactate?

"Anaerobic Threshold"

The old ideas about lactate are closely related to the anaerobic threshold myth. It was once thought that at some point during increasing exercise intensity, a lack of oxygen to working muscle caused a large increase in lactic acid which in turn caused fatigue. This exercise intensity was called the anaerobic threshold, mistakenly assuming a shift from aerobic to anaerobic metabolism. However, aerobic metabolism is always occurring, even at maximal workloads. Despite the continued use of this term today by coaches and athletes, we have known for nearly two decades that no "anaerobic threshold" exists.

What causes fatigue?

We know, however, that there is a performance "threshold" of some kind. Beyond this threshold, fatigue occurs. The belief of lactate or "lactic acid" as the cause of fatigue was a convenient explanation for complex processes. Since the appearance of lactate increases as exercise intensity increases, and as exercise intensity increases, fatigue increases, it was assumed that lactate *caused* fatigue. However, a correlation does not imply causality. For example, heart rate increases as exercise intensity and fatigue increase, but we know that increased heart rate does not *cause* fatigue. The same is true of lactate. Some will claim that this is a case of semantics, that if it's not the lactate, then it must be the "acid" part of lactic acid that causes fatigue. There is compelling scientific evidence to the contrary.

Lactate & Lactic Acid

Within the muscle cell, anaerobic metabolism results in the production of lactate and hydrogen (among other products). However, the fates of these two substances are distinctly different. An exercise scientist or coach measures blood lactate, *not* lactic acid during exercise testing. Lactate is actually an important fuel that is used by muscle (aerobically) and by the liver to make glucose. Hydrogen (H^+) is an ion that is ever-present in the body within various forms (e.g. H_2O). The accumulation of H^+ within the muscle cell increases acidity. As the body continually works to maintain a narrow range of pH (acidity – alkalinity), hydrogen (H^+) that accumulates can be buffered to carbon dioxide (and exhaled) or to water. While there is evidence that H^+ accumulation beyond the buffering capacity can inhibit muscular contraction, recent research suggests that it is not an increase in acidity but rather an accumulation of inorganic phosphate (CP-ATP energy pathway) or the progressive loss of potassium from inside the muscle cell that are the primary causes of fatigue.

Athletes have long been taught that lactate accumulation causes fatigue. If scientific experimentation indicates this to be incorrect, what is lactate then? According to Dr. Benjamin Miller of the Institute of Sports Medicine in Copenhagen, “Lactate is: 1) a valuable energy source within working muscle, non-working muscle, and the heart, 2) quantitatively, the most important contributor to the making of glucose in the liver, and 3) subject to training-induced improvements in its use as a fuel.” It is not the terrible substance we once thought it to be. If this is the case, why are we measuring lactate? What is lactate threshold, and what is its application to training and performance? In part two next month, we will examine lactate and the lactate threshold more closely.

Dario Fredrick, M.A. is an exercise scientist and the head coach for Whole Athlete™. He can be reached at www.wholeathlete.com.