

An Athlete's Chemical Affair: Lactate as a Fuel

By Rob Lockey, CSCS

As the science of sport evolves, coaches like me must learn to adapt to the new thoughts on how the human body reacts to exercise. In the not so distant past it was believed that lactate caused the muscles to stop working...brought on fatigue...and an athlete wouldn't be able to do anymore work once they went beyond the threshold for lactate. A much larger school of belief now looks at lactate as an important tool in an athlete's toolbox.

Well, to tackle the subject of metabolic pathways in a short article will surely be a tough task and I hope to show you the complexity and then explain the simple fact of what is happening. So, the first part of this article about lactate as a fuel will be like reading the ingredient list on a frozen pizza: enriched wheat flour, cyanocobalamin, orthophosphate...what? The explanation at the end will help you to understand that pizza (lactate) is useful for completion of a workout. Lactate in its simplest form is a salt or ester (chemical compound) of lactic acid.

An abundance of information is available about lactate and its possible roles in exercise. There are some conflicting thoughts on the subject and I suspect in the years to come more information will come out that science can agree on. I have searched many places and read many versions along with providing testing for lactate and feel the below adaptation taken from Wikipedia lays out the possible path lactate follows in our exercising body as a fuel.

"The Cori cycle, named after its discoverers, Carl Cori and Gerty Cori, refers to the metabolic pathway in which lactate produced by anaerobic glycolysis in the muscles moves to the liver and is converted to glucose, which then returns to the muscles and is converted back to lactate. Muscular activity requires energy, which is provided by the breakdown of glycogen in the skeletal muscles. The breakdown of glycogen, a process known as glycogenolysis, releases glucose in the form of glucose-6-phosphate (G-6-P). G-6-P is readily fed into glycolysis, a process which provides ATP to the muscle cells as an energy source. During muscular activity, the store of ATP needs to be constantly replenished. When the supply of oxygen is sufficient, this energy comes from feeding pyruvate, one product of glycolysis, into the Krebs cycle. When the oxygen supply is insufficient, typically during intense muscular activity, energy must be released through anaerobic respiration. Anaerobic respiration converts pyruvate to lactate by lactate dehydrogenase. Most importantly, fermentation regenerates NAD^+ , maintaining the NAD^+ concentration so that additional glycolysis reactions can occur. The fermentation step oxidizes the NADH produced by glycolysis back to NAD^+ , transferring two electrons from NADH to reduce pyruvate into lactate. Instead of accumulating inside the muscle cells, lactate produced by anaerobic fermentation is taken up by the liver. This initiates the other half of the Cori cycle. In the liver, gluconeogenesis occurs. From an intuitive perspective, gluconeogenesis reverses both glycolysis and fermentation by converting lactate first into pyruvate and finally back to glucose. The glucose is then supplied to the muscles through the bloodstream; it is ready to be fed into further glycolysis reactions. If muscle activity has stopped, the glucose is used to replenish the supplies of glycogen through glycogenesis. Overall, the glycolysis part of the cycle produces 2 ATP molecules at a cost of 6 ATP molecules consumed in the gluconeogenesis part. Each iteration of the cycle must be maintained by a net consumption of 4 ATP molecules. As a result, the cycle cannot be sustained indefinitely. The intensive consumption of ATP molecules indicates that the Cori cycle shifts the metabolic burden from the muscles to the liver. (Adapted from Wikipedia)"

So, just a few things going on...well maybe more than a few. To break this down to a simpler form: when we attain greater intensities during exercise, more work is done in the absence of oxygen (anaerobic). The fuel that provides the energy for this exertion is glucose and when used in this anaerobic state, the return on the investment (eating) is less (we get far more energy for glucose when broken down in the presence of oxygen). Lactate allows for the system to gain some returns by replenishing the glucose

supply that the muscle will use to continue the intensity. Lactate at this point is not the evil byproduct that slows your performance, but the component that prolongs your ability. Training will improve your ability to be more aerobic at higher intensities and produce less lactate while also becoming more efficient with your use of lactate as a fuel source.

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Measure of Blood Lactate from a threshold test. Measured in mmol/L (millimoles per Liter), a molecular count of lactate per liter of blood. Resting falls around 1.5mmol/L and very hard exercise can have upwards of 20mmol/L.