**The Performance Benefits of Lactate Threshold Testing and Training**

Whether you are a triathlete, runner, skier, cyclist, or rower, as an endurance athlete you need accurate physiological data to guide and monitor your training by. Lactate threshold is one of the most commonly, and effectively, used performance markers used by many athletes and coaches. The point is to learn the highest intensity at which you race and train before hitting the wall from high levels of blood lactate. Elite athletes and coaches know the key to success is to increase sustainable power on the bike and speed while running at lactate threshold. You may be asking what is lactate threshold? How do you test one’s lactate threshold? And most importantly, how does one train to increase their lactate threshold?

**What is Lactate Threshold?**
The energy required to move is supplied from the breakdown of adenosine triphosphate (ATP). The body can only store about 85 grams of ATP and would use it up very quickly if our bodies did not have a few ways of resynthesizing it. There are three energy systems that produce energy: ATP-PC (short, explosive movements), glycolytic (intermittent hard intervals) and aerobic (endurance exercise). Athletes most commonly attribute the intense burning felt during exhaustive bouts of exercise to the accumulation of lactate in the blood which is produced by the higher level of exercise intensity.

When you demand energy faster than your aerobic energy system can produce it, your glycolytic energy system picks up the slack. Even though the glycolytic energy system is often characterized as “anaerobic” (literally meaning without oxygen), it’s not that there’s no oxygen available, but rather that your aerobic system is going as fast as it can and you still need more energy. The glycolytic system is fast but it’s less efficient and produces less energy, per unit of fuel burned, than the aerobic system. Your body has to clear the lactate from the blood and working muscles and process it back to useable fuels, and lactate threshold is the point at which production outstrips the clearing process and higher levels of blood lactate start to accumulate in the muscles. Lactate threshold can be determined through lactate threshold testing, verified within your training program, and used to make you stronger and faster.

**Why Lactate Threshold Matters**
Your lactate threshold essentially defines the upper limit of your sustainable efforts in training and competition. Once you cross over and rely more heavily on your glycolytic system for energy, you’re exercising on borrowed time. The accumulation of blood lactate will hinder your muscles’ ability to contract, and you will be forced to slow down or stop. The more work you can do before reaching lactate threshold, the better. If the pace you can hold at your lactate threshold is higher than the pace your competitor can hold at his or her lactate threshold, you go faster, reach the finish first, and win.

Being able to do more work at lactate threshold also means maintaining a lighter pace is even easier. While your main rivals are burning energy fast, riding at their limits, you can stay right with them and rely primarily on your aerobic system. This saves valuable energy for hard efforts later, like the run leg of a triathlon, a long climb to the finish line, or a sprint.

**Lactate Threshold Testing**
Lactate threshold (LT) testing can be utilized to determine an appropriate training intensity and monitor progression in athletes of all levels. This test is similar to the VO2 max test, although consists of slightly longer periods of time between changes in workload. This test does involve several blood samples taken from the finger for the assessment of blood lactate. It is not considered a maximal test but does require a high intensity effort.

There are numerous protocols for conducting lactate threshold, and the one used by the US Olympic Committee and Carmichael Training Systems is described here. First, the athlete is taken through a proper warm up on the cycling trainer or treadmill (the example below is for cycling, but the treadmill protocol is very similar). The athlete rides on an electronically-braked bicycle (this means that the workload, in watts, stays the same even if you change the cadence) starting at a fairly easy load. After the first four-minute stage, the workload is increased by approximately 25 watts every three minutes. Before the watts are increased, within the last 60-30 seconds of each stage, rate of perceived exertion (RPE), heart rate (HR) and blood lactate (mmol/L) are taken. Athletes typically ride about 7-8 stages, or until a break point in your blood lactate values has been distinguished. This break point area is known as your lactate threshold. You are said to have crossed lactate threshold when blood lactate concentration increases by at least 1 mmol/L in two consecutive stages.



The above graph was taken from a lactate threshold test performed on a SRM cycling ergometer. According to the graph, a 1 mmol/L jump followed by another 1 mmol/L jump occurred at 250 watts and then again at 275 watts. Therefore, this individual’s lactate threshold occurred around 250 watts.

An athlete’s initial lactate test provides an indicator of fitness level and a starting point for training. Depending on the protocol used, the following data can be acquired through a lactate test: maximum sustainable power (cycling) or pace (running), recovery heart rate (how quickly the athlete’s heart is able to return to recovered levels), pace and power at lactate threshold, and a relative index of fitness (i.e., speed or power divided by the athlete’s body weight). In all, the athlete walks away with an immense amount of useful performance information. However, the real power of lactate threshold testing comes from comparing test results over time. Provided you’re training and striving to improve, regular lactate testing provides you and your coach with concrete evidence of improvement, or lack thereof, throughout the season(s). A history of lactate tests should show changes in fitness, characterized by: increased power and/or pace at threshold, improved recovery heart rate, a higher lactate threshold heart rate, and a higher pace or power-to-weight ratio.

If you do not have access to a testing center like the CTS Training Centers in Colorado Springs, Colorado; Brevard, North Carolina, Tucson, Arizona, and Santa Ynez, California you can still generate accurate values for training intensities values from a field test. For the cycling test, find a 5-10km section of road that is either flat or slightly uphill (no more then 5-6% grade). You will perform two maximal efforts starting at the same point. The recovery period typically consists of slowly returning to the initial starting point for the second effort. During both efforts it is important to record the average power and/or heart rate. Since there are no blood samples in a field test, you can’t necessarily say the data provides your lactate threshold power or heart rate. In fact, the vast majority of people can average about 10% above threshold for a 5-10k field test. Taking this into account, you can still calculate accurate training intensities from field tests, as CTS proved in a 2007 study by Klika et al., (J Strength Cond Res. 2007 Feb;21(1):265-9) performed during CTS indoor training classes.

**Lactate Threshold and Training**
Gathering information about your body and lactate threshold doesn’t do you much good unless you incorporate it into your training. Working on improving pace or power at lactate threshold typically occurs after you’ve already laid down a strong foundation of aerobic work. For the summer-time competitor, this usually means performing lactate threshold work in the mid spring. Following several training blocks devoted to targeted interval workouts, you’ll progress to even harder, yet shorter, workouts as you approach your goal event.

Consistency is the key to improving performance at lactate threshold. You have to accumulate a lot of work at a steady workload to place the appropriate amount of stress or load on the system. Since you can’t spend a lot of time working above threshold, these training intervals have to be at an intensity just below your threshold.

For both running and cycling, interval workouts focused on improving performance at threshold should progress from 5-minute intervals to intervals of up to 20 minutes in length. Recovery between intervals should stay at about one third to half the length of the interval. Your first goal is to accumulate time with multiple shorter intervals, and then progress to performing fewer, longer intervals. Lactate threshold workouts are hard on the body, and it’s best to put a day of light endurance training or active recovery between days of lactate threshold training.

Through training, the body learns to contract muscles repeatedly with force and quickness without too much buildup of blood lactate. If the muscles can increase workloads or stress while maintaining a faster pace at aerobic levels, you can spare muscle glycogen while at the same time decreasing the amount of blood lactate produced. When you have increased the work you can do before reaching lactate threshold, and the power you can produce when you’re there, you can move on to training that very specifically sharpens your event-oriented skills and begins the taper towards your goal event(s). During this training period, you generally keep a little intensity going in order to stay fresh and powerful, but you also need to make sure you have plenty of recovery to restore and replenish all of your energy systems.

You want to make the most of the time and energy you have available. You can wander through various books and pick up new ideas and try new trends, but the reality is that the fastest and safest way forward to peak performance and everything you what from your sport, is through methods proven through years of success. Lactate threshold testing is one such method, and it’s becoming more readily available to the public every day. Give it a try and put some precision into your training this season.

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