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Area of Interest: Understanding Metabolics (Conditioning)

Topic: Anaerobic or Lactate Threshold Training

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When conditioning our athletes we must take many factors into consideration. We must look at the demands of the sport, more specifically the amount of time spent in continuous movement, the speed and intensity of that movement and the amount of recovery time between bouts of strenuous movement. We also have to look at the contributions made from each of the 3 energy systems during bouts of strenuous movement as well as recovery. Nothing works in a vacuum. There is never a point where one system is working independent of the other two. So taking all this into consideration we see the need to develop (at least partially) each of the three energy systems for most team sports. First, let's review the three energy systems:

1. **Short Term – ATP/PC System: In simple terms the body quickly breaks down the available ATP in the system to use for quick explosive energy. When the demand is too high (sprinting at max speed) the body can't process the byproducts of this reaction efficiently. Thus causing it to slow down (usually after 5-8 seconds at maximal pace).**
2. **Intermediate – Lactic System or Anaerobic Glycolysis: This system kicks in as the body is unable to process the byproducts of the Short Term System's reactions, thus causing a virtual traffic jam at the mitochondria. This causes a protective, supplemental energy system to kick in to get you the energy you need to go hard (but not as hard as the Short Term) for 10 seconds to 2 minutes. The harder you go the more backed up the system gets (as well as more acidic) causing the "burn" that gave rise to the term Lactic Acid.**
3. **Long Term – Aerobic System: When you are exercising at a slower pace that doesn't fully tax the Short Term system the process you end up creating a homeostasis where the system can keep up with the demands of the exercise. This system is the most efficient. If you can develop the Long Term Energy System you will reap the benefits as the other two systems will operate much more efficiently.**

Now remember all three of these systems are working together, but at any given time 1 is usually out working the others. Therefore training the Short Term Energy System (STES) will give you gains in explosive power and speed. Training in the Intermediate Energy System (IES) will develop a more efficient way of dealing with that "traffic jam" as well as desensitizing the body to the burn resulting from the acidosis associated with this back up at the mitochondria. Training in the Long Term Energy System (LTES) will result in increased recovery time, resistance to fatigue and the ability to go at steady paces for longer periods of time.

For the purpose of this article we will focus on the IES and more specifically training the Lactate or Anaerobic Threshold, or the point in strenuous exercise where the amount of accumulation of blood lactate exceeds the amount of removal of blood lactate. Due to the assumption that most athletes fatigue due to increased amounts of lactate in the blood, resulting in decreased muscle function, burning in the muscles, increased breathing, etc, some might argue that if you can delay this state (either by increasing the body's tolerance to lactate, or by removing the lactate more efficiently) you will be able to go harder for longer periods of time with quicker recovery.

Identifying Anaerobic (Lactate) Threshold:

Identifying Anaerobic Threshold is the most important measure when assessing an athlete's conditioning level. We traditionally hear a lot about VO2 Max and its important role in athletics. The truth is, VO2 is an important tool for talent identification, but doesn't have a large impact on daily training. This is because VO2 is rather dependant upon genetics. It can be trained to a certain degree, but at the end of the day, most athletes aren't going to have a VO2 Max above 65 ml/kg/min. That doesn't mean that they can't compete at a high level of athletics when trained correctly. In fact, Lance Armstrong did not have the highest VO2 in the Tour de France, however he did have the best anaerobic fitness and lactate tolerance.

Most formulas are inconsistent and do not provide accurate heart rates for anaerobic threshold. There are now several testing devices available, including the iMett, (a 6-10 minute graded test on a treadmill or bike using a face mask and heart rate monitor) which provides a simple and effective way of identifying anaerobic threshold. The iMett doesn't use an O2/CO2 analyzer like its pricey and difficult predecessors, rather, it analyzes ventilation, heart rate and power simultaneously to allow the trainer to look and the big picture and pinpoint the anaerobic threshold.

Anaerobic threshold is highly trainable and will frequently vary depending upon the athlete's training status. The better the athlete's anaerobic fitness, the higher the anaerobic threshold; the better the aerobic fitness, the more intensity the athlete can tolerate for long durations. Because the LTES is the most efficient of the three energy systems, it only makes sense that it is advantageous for athletes to utilize this energy system as much as possible during competition. By pushing the Anaerobic Threshold to higher and higher limits, athletes will be able to compete at high levels of intensity while staying aerobic and not producing Lactic Acid, and thus not fatiguing.

The iMett will identify max heart rate, anaerobic threshold heart hate, 2 minute recovery heart rate, VO2, and caloric expenditure, among other things. As discussed, the anaerobic threshold heart rate, max heart rate and the recovery heart rate are the most crucial for training speed and power athletes. Ideally, the anaerobic threshold heart rate will be very close to the max heart rate, while the recovery heart rate will be much lower than that of the anaerobic threshold.

Training for Anaerobic Capacity:

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Once the numbers are determined, the exercise prescription can be made. In order to push the anaerobic threshold higher and teach lactate tolerance, the athlete has to train at high levels, utilizing the STES and IES, thus producing large amounts of lactate. Research shows that the three best means of training for anaerobic capacity are:

1. **Interval sprint training: This is done by performing short, very intense runs, followed by periods of recovery. It is performed best when the work to rest ratios simulate the sport. The anaerobic capacity is trained by challenging the body's lactate shuttle system to clear the lactate during the rest intervals prior to initiating the next run.**
2. **Resisted Running: Resisted running is done by performing sprints with some form of outside force making it more difficult for the athlete to reach top speeds. The vast majority of research in the field supports the use of uphill running to achieve this, but in recent years, devices such as the Woodway Force treadmill has become another means of successfully performing resisted running. The IES is challenged because of the great number of total motor units that are recruited to propel the body under load. The increased muscle activity produces a greater amount of byproduct. Whichever technique used, it should be stressed that the loads are not so great that they slow the athlete more than 10% and proper sprint mechanics should not be sacrificed. If the resistance slows the athlete greater than 10%, it becomes a strength exercise rather than a speed exercise. Here are two studies that we have done at CAP using Resisted Interval Sprint training:**
    a. **http://www.capprogram.com/newsinfo/linearpowerlateralpower.html**
    b. **http://www.capprogram.com/newsinfo/resistedintervalstudy.html**
3. **Overspeed Training: Overspeed training is done by forcing the body to run at speeds higher than they are accustomed to. By doing this, the efficiency of the nervous system is improved, thus making the athlete faster. It affects anaerobic capacity by forcing the body to once again recruit more motor units that normal and increasing the byproduct load. In this case, the motor units being recruited are acting synergistically as stabilizers as the body adapts to new stimulus.**

Performing one or more of these training techniques will teach the body to handle lactate and push their anaerobic fitness to new levels. These high intensity workouts can be performed 1-2 times per week, along with workouts of medium and low intensity to provide the metabolic systems with variation and allow them the opportunity to recover. It should be noted that there has been success with anaerobic fitness training on high speed treadmill units. These workouts are able to combine all three components of anaerobic conditioning simultaneously, thus creating an environment which can not be duplicated on any field of play. For more information on high speed treadmill training, visit www.maximumtrainingsolutions.com/EXSpeed.html. MTS provides background information along with some interesting case studies (see www.maximumtrainingsolutions.com/

By teaching the body to properly deal with Lactate and push the Anaerobic Threshold higher, your athletes will run faster and jump higher for longer durations, making fatigue a thing of the past.