**Lactate**
***( From the 'Lore of Running'- 4th edition by Prof Tim Noakes)***

There are so many misconceptions surrounding the glycolytic product know as lactate.
Lactate is both produced and used by the muscles, its rate of production increases as the exercise intensity increases and as more carbohydrate is used to fuel exercise.
In the body lactate usually exists in combination with sodium (as sodium lactate) not in the acidic form of lactic acid.

- **Original Thinking**
- The original thinking was that muscles only began to produce lactate when their oxygen supply was inadequate to meet their oxygen demand. The muscles therefore became anaerobic and as a result, the end-products of glycogen breakdown could not be metabolised in the mitochondria, as oxygen is required in order for them to function.
- The prevailing belief was that blood lactate concentrations suddenly increased at a threshold exercise intensity, variously called the anaerobic threshold, the lactate turn point, or the ventilation threshold. The term 'lactate threshold' is limiting in that it identifies a point that is determined visually, not mathematically, and that it suggests some sort of abrupt threshold when no such threshold exists. With the lack of a suitable alternative, we have continued to use the term 'lactate turn point'. The lactate turn point might be best defined as the exercise intensity or running speed that produces a blood lactate concentration of 3mmol per litre per minute during a progressive maximal exercise test to exhaustion. This is because when exercise is continued at running speeds below that critical speed blood lactate concentrations do not rise further but tend to fall. This suggests that exercise intensity can be sustained for some reasonable time.
- **High Intensity Exercise**
- As the exercise intensity increases, the rate of carbohydrate use by the body increases. As a result, glycolysis is activated; lactate production in both Type 1 and Type 2 muscle fibres rises, so that at the lactate turn point, lactate production exceeds the rate of lactate consumption in the exercising skeletal muscles. Lactate them appears in increasing amount in the arterial and venous blood. This way, lactate is shuttled to other tissues, in particular the liver, the heart and the inactive skeletal muscles. The liver may use lactate for producing new glucose and glycogen; in the heart, lactate becomes the preferred fuel for oxidative (mitocondrial) metabolism. The inactive muscles store the lactate, thereby lowering the lactate concentrations in the blood and active muscles. Lactate is metabolized to glycogen in the inactive skeletal muscles and enters the blood stream to be used by glycogen depleted active

  When high-intensity exercise (greater than 85 –95% VO2max) is achieved, virtually all energy comes from carbohydrate oxidation. This means that the rate of energy flow through the glycolytic pathway increases steeply with increasing exercise intensity, the result is that the rate of lactate production increases inside the muscle. The high rate of glycolytic turnover also produces acidic (hydrogen ions) or protons, which acidify the inside of the muscle cell. To counteract this, the protons are exported from inside the cell into the blood stream but this process requires that blood lactate is co-transported with the protons. In this way lactate appears in the blood

stream whenever the use of carbohydrate use is high. The presence of lactate in the blood stream is a by-product of a process that aims to prevent the muscle from becoming acidic to rapidly.

Within an hour of an intensive interval training session, during which blood lactates reach the highest achievable value (15mmol.*l*-1) muscle lactate values will return to normal.

**Blood Testing**

- Blood lactate testing could be used to monitor an athlete's fitness level if repeated frequently during training. However, in reality, it is relatively time- consuming to accurately identify the lactate turnpoint in the laboratory. Also. It is probably a less accurate predictor of marathon performance than either the peak treadmill running velocity measured during the VO2max test; the prediction based on racing performance over shorter distances and/or, even the athletes own prediction, provided that he or she is an experienced marathon runner. Indeed, in equally well trained cyclists, measurements of blood lactate parameters during exercise were found to be of negligible value in predicting their performances.

- Despite the hype that surrounds the value of lactate testing in predicting the performance in runners, the expectations have not been met. Changes in blood lactate concentrations during exercise can give some indication of whether the athletes fitness has improved or regressed, but there is little added value in using blood lactate measurements for the prediction of performance
- Lactate is a totally innocuous substance that, if infused into the blood stream, has no noticeable effects. Rather it is the excess acidic hydrogen ions released during rapid carbohydrate turnover that may be related to fatigue during high intensity exercise.

The shortened extracts on lactate are a very small part of the chapters in the over 1000 pages of the book *Lore of Running (4$^{th}$ edition).*