Aerobic Energy System

- FITT – ACSM Guidelines
  - Frequency: 3-5 days/week
  - Intensity: 60-90% HRmax
  - Time (duration): 20-60 mins cont/broken
  - Type (mode): any activity that uses large muscle groups, can be maintained continuously and is rhythmical and aerobic in nature

- VO2 max Improvement:
  - Influencing factors:
    - Initial state of fitness
    - Quantity of training
    - Heredity

- VO2 max can increase with endurance training as much as 15-20% in 2-3 months
- High correlation between VO2max and endurance performance
- VO2 is expressed as L/min (absolute) or ml/kg/min (relative) – this depends on mode of exercise, subject characteristics and purpose of any comparison in values

- Reasons for increased VO2max:
  - Increased Q is 50% of reason
  - Increased SV
  - Increased heart volume
  - Increased strength of contraction
  - Improved oxygen extraction (a-vO2 diff.)
  - Increased capillaries
  - Increased diffusion of O2 to muscle fibers

- Increased size and number of mitochondria
- Increased enzymatic reactions
Table 13.2: Metabolic adaptations to end.

- Adaptation and Consequence
  - VO2max - end. Performance
  - Muscle glycogen - more work before onset of fatigue
  - Mitochondrial enzymes - oxidative capacity
  - Use of fats as substrate - less reliance on glycogen, less glycogen depletion

- LA removal and oxidation - more work before onset of fatigue
- LT (LA threshold) - more work before onset of fatigue

Lactate and Ventilatory Thresholds
The exercise intensity at the lactate threshold (LT) or ventilatory threshold (VT) provides the best measurement that can predict athletic performance in middle to long distance (duration) events.

There are currently no universally accepted guidelines for measuring the LT, and several methods exist for documenting a threshold change in blood lactate.

More concrete guidelines exist for the VT, with one of two methods being acceptable in research (see Figure 8.10):
- Ventilatory equivalents (VE/VO2 vs VO2)
- V-Slope (VCO2 vs VO2)

Lactate Threshold
Refers to the exercise intensity where there is an abrupt increase in either of muscle or blood lactate.

Figure 6.8B

To improve the detection of this threshold, researchers transform the lactate values to their log10 expression.

Figure 6.8A
What causes the LT?

- ↑ Production of lactate
- ↑ Removal of lactate
- ↑ Fast twitch motor unit recruitment
- Imbalance between glycolysis and mitochondrial respiration
- Ischemia
- Muscle hypoxia
- ↓ Redox potential (NAD⁺ / NADH)

Other Lactate Threshold Terminology

**Anaerobic threshold** - first used in 1964 and based on increased blood lactate being associated with hypoxia. Now known to be an oversimplification, and should not be used.

**Onset of blood lactate accumulation (OBLA)** - the maximal steady state blood lactate concentration, which can vary between 3 to 7 mmol/L.

Research has shown that there is considerable similarity in each of the exercise intensities obtained from the different lactate threshold methodologies.

**Remember** that the limitation to exercise above the LT is not the increased blood and muscle lactate but the associated increase in acidosis and other markers of muscle fatigue.

**QUESTIONS**

1. What do researchers currently do to verify that a VO₂max was attained?
2. Why are there so many units to express VO₂max?
3. What are the variables that will influence VO₂max?
4. Why do exercise physiologists measure VO₂max?
5. Why do exercise physiologists measure the LT?

Adaptations During Steady State Exercise

a. Oxygen Kinetics

Note the slower response time to steady state for untrained

**Figure 6.9A**

**Figure 6.9B**

Note the faster response time but slightly delayed steady state for larger intensity increments