Respiration and Exercise

Response to Exercise: Increased Demand for Energy

- During exercise, **muscle cells contract** more often to create movement.
- Muscles require energy to contract so will need to **respire** more to meet the energy demand.
- The body must supply the respiring cells with more **oxygen** for the increased respiration and also remove the **carbon dioxide** that is produced.
- It does this in three ways:
  - **Increasing heart rate** —>increases rate of **blood flow** around the body.
  - **Increasing breathing rate**—> increases the rate of **gas exchange** in the **lungs**.
  - **Increasing breath volume**—> increases the rate of **gas exchange** in the **lungs**.
- If **insufficient oxygen** is available to the muscles, for instance the exercise is vigorous and/or prolonged, the heart and lungs are unable to supply sufficient oxygen.
- Muscles begin to respire anaerobically. **Lactic acid** is produced from glucose, instead of carbon dioxide and water.
- During long periods of vigorous activity:
  - lactic acid levels build up
  - glycogen reserves in the muscles become low as more glucose is used for respiration, and additional glucose is transported from the liver.
  - This build-up of lactic acid produces an oxygen debt.

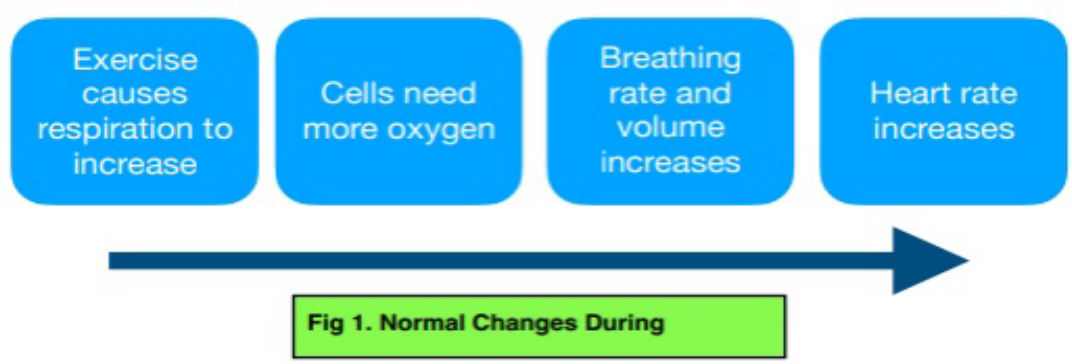

Fig 1. Normal Changes During

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Anaerobic Respiration leads to Oxygen debt

- **Liver** converts **lactic acid back to glucose** which needs oxygen.
- When a period of exercise is over, lactic acid must be removed. The body's tolerance of lactic acid is limited.
- Lactic acid is taken to the liver by the blood, and either:
  - oxidised to carbon dioxide and water, or
  - converted to glucose, then glycogen - glycogen levels in the liver and muscles can then be restored
- These processes require oxygen. This is why, when the period of activity is over, a person's breathing rate and heart rate do not return to normal straightaway.
- The amount of oxygen required to remove the lactic acid, and replace the body's reserves of oxygen, is called the **oxygen debt**.

Investigating the Effects of Exercise

- Simple investigations can be carried out to determine the effects of exercise on the body such as comparing breathing rate or heart rate before and after exercise.
- Breathing rate can be calculated by counting how many **breaths** a person takes in a **minute**.
- Heart rate can be calculated by measuring the **pulse over a minute.**
- The results can then be plotted on a simple bar chart.
- **Monitoring breathing rate and heart rate** can help determine the **physical fitness** of an individual.