Review: $O_2$ and $CO_2$ Transport

**Oxygen** is transported in two ways:

1. 97% is carried in the red blood cells bound to haemoglobin as **oxyhaemoglobin**.
2. 3% is carried dissolved in the plasma.

**Carbon dioxide** is transported in three ways:

1. 70% combined with water within the red blood cells as **carbonic acid**.
2. 23% combined with haemoglobin as **carbaminohaemoglobin**.
3. 7% dissolved in the plasma.
Dynamics Part I: Warm Up

- Warm up – effects on vascular system
- Gradual increase in blood flow brings more oxygen to working muscles
- An increase in temperature produces
  1. An increase in the rate transport of enzymes needed for the energy systems.
  2. A decrease in the viscosity of the blood which improves blood flow
  3. An increase in oxygen dissociating from oxyhaemoglobin
- A warm up delays the onset of blood lactic acid

Dynamics Part II: Cool-Down

- An active cool down keeps respiratory and muscle pumps working which prevents blood pooling in the veins and maintains venous return.
- Capillaries remain dilated which means more oxygenated blood reaches the muscles which results in more lactic acid and carbon dioxide being removed.
- Blood lactate to zero when cool down at 30-40% VO₂ max for ~17 minutes
- Concept review: how are SV, HR, Q affected during active cool-down? What happens?
Dynamics Part III: Training and Exercise

- Oxygen uptake…
- is the amount of oxygen that is consumed by the body due to aerobic metabolism
- It is measured as the volume of oxygen that is consumed (VO$_2$) in a given amount of time, usually a minute
- Oxygen uptake increases in relation to the amount of energy that is required to perform an activity
- (VO$_2$ max): a measure used to evaluate the maximal volume of oxygen that can be supplied to and consumed by the body

Training and Oxygen Uptake

- Changes in hematocrit (concentration of red blood cells in the blood) can also alter the oxygen uptake by increasing or decreasing the amount of oxygen that is supplied to working tissues.
- The ability of the tissues to extract oxygen (a-vO$_2$ difference) directly affects the oxygen uptake.
- a-vO$_2$ difference: O$_2$ level in arterioles vs. O$_2$ levels in venules (pre- and post-capillary)
- Increases in a-vO$_2$ difference may arise due to an increased number of mitochondria in the muscles, or increased enzyme efficiency in working tissues
More on Dynamics Part III

- **Increased capillarization** (number of capillaries in tissue) can affect the ability of the circulatory system to place red blood cells close to the tissues that are using the oxygen.

- As a result, this increases the ability of those tissues to extract the required oxygen due to a shorter diffusion distance.

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**Oxygen Uptake and Training: The Fick Equation**

\[ \text{VO}_{2\text{max}} = \text{Cardiac Output (Q)} \times (a-v\text{O}_2) \text{ difference} \]

- A. Fick (1829-1901) developed this relationship in 1870
- \(Q\) = cardiac output (the amount of blood pumped by the heart in one minute
- Essentially the relationship between the amount of oxygen (marker) taken up by an organ (muscle) and the difference between oxygen (marker) in arterial and venous blood at that organ
- Factors influencing this relationship include:
  1. the ability of the lungs to oxygenate the blood
  2. the ability of the body to extract that oxygen.

- Training can increase the maximal oxygen consumption of the human body. Brainstorm: how is this accomplished???
Applied Physiology: The VO₂ Max Test

- [https://www.youtube.com/watch?v=HpwlxBOmhBI](https://www.youtube.com/watch?v=HpwlxBOmhBI)
- The test explained
- [https://www.youtube.com/watch?v=Ad_sN6Vjt4E](https://www.youtube.com/watch?v=Ad_sN6Vjt4E)
- Reading soccer team takes the test…
- [https://www.youtube.com/watch?v=A2z0l9B6aGE#t=413.3290384](https://www.youtube.com/watch?v=A2z0l9B6aGE#t=413.3290384)
- Exercise physiologists at Northern Illinois University
- [https://www.youtube.com/watch?v=hwqd13jS5FY](https://www.youtube.com/watch?v=hwqd13jS5FY) …this one if you’re not into running but would rather row…