Maximum Oxygen Consumption - VO$_2$ Max

(Text Pg 129 – 130)

What is VO$_2$?

VO$_2$ is the amount of O$_2$ taken up and consumed by the body for metabolic process in a minute. It is equal to the amount of O$_2$ inspired minus the amount of O$_2$ expired.

How is VO$_2$ Calculated?

1. **The Fick Equation (theoretical)**

   \[ VO_2 = Q \times a - vO_2 \text{ diff} \]

   - Difficult to measure $a - vO_2$ diff
   - Difficult to measure SV

2. **In the Exercise Physiology lab (practical)**

   - Progressive exercise test to max.
   - How do we know if someone is working at or near max?
   - $VO_2 = \text{Volume of O}_2 \text{ inspired} - \text{Volume of O}_2 \text{ expired}$

**Note:** At rest, only about a quarter of the oxygen in the inhaled air is taken up by the blood in the lungs.

VO$_2$ Max

- The maximum volume of O$_2$ consumed by the body for metabolic **production of ATP** during exercise.
- One of the oldest and best measures of human performance and aerobic fitness (i.e. the fastest rate at which we can make ATP aerobically)

Two Determining Factors for VO$_2$ Max

1. **Volume of blood moved (Q)**
   - Larger Q = Higher VO$_2$ max

2. **$a - vO_2$ diff**
   - **Oxygen Carrying Capacity of the Blood**
     - Amount of hemoglobin in red blood cells (Anemia)
   - **Efficiency and Amount Exercising Skeletal Muscle**
     - # of mitochondrion & aerobic enzymes
     - More muscles exercising = more oxygen consumption.
What Limits VO₂ Max?

- Respiratory Limitations?
  - Healthy Individuals are not limited by their respiratory system, the blood is always saturated with O₂ under normal atmospheric conditions.
  - Inadequate ventilation
    - Asthma, smoker, etc.
  - Poor saturation of Hgb (Oxy-hemoglobin saturation curve)

- Skeletal muscle Efficiency?
  - Can be limiting for untrained yet our skeletal muscles are very good at extracting O₂ from the blood.
    - Extraction of metabolically active tissue is ~ 85%
  - With training our muscles get better at this (↑ a-v O₂ diff)
    - ↑ # of mitochondrion = ↑ cellular respiration
    - ↑ capillarization = ↑ more blood to muscle

- Cardiovascular limitations?
  - The delivery of blood to the lung and working tissues is the main limiting factor in achieving a higher VO₂ max (debatable).
    - Only have so much blood (5 – 6 L and 15g/100 ml of Hgb)
    - Heart can only beat so fast (220 – age)
    - Heart can only beat so hard (SV max ~ 300 ml/beat)
  - With training our Cardiovascular System shows a considerable training effect.
    - Bigger & stronger heart, better venous return = ↑ SV
    - Blood volume and Hgb does increase = ↑ O₂ carrying capacity of blood.