

Maximum Oxygen Consumption - VO₂ Max

(Text Pg 129 – 130)

What is VO₂?

VO₂ is the amount of O₂ taken up and consumed by the body for metabolic process in a minute. It is equal to the amount of O₂ inspired minus the amount of O₂ expired.

How is VO₂ Calculated?

1. *The Fick Equation (theoretical)*

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

- Difficult to measure a – v O₂ 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?
- VO₂ = Volume of O₂ inspired - Volume of O₂ expired

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

VO₂ Max

- The maximum volume of O₂ 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 VO₂ Max

1. Volume of blood moved (Q)

- Larger Q = Higher VO₂ max

2. a – v O₂ 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.