Maximal Aerobic Capacity (VO$_{2\text{max}}$)

**Fick Equation**

\[ \text{VO}_2 = \text{HR} \times \text{SV} \times \text{a-vO}_2\text{diff} \]

**Absolute VO$_2$**
- The total volume of oxygen consumed.
- Expressed as L/min

**Relative VO$_2$**
- The total volume of oxygen consumed related to body weight
- Allows comparison of aerobic fitness among individuals of various body size
- Expressed as mL/kg/min

**An Example**
If you are 70kg and have an absolute VO$_2$ of 3.5 L/min, what is your relative O$_2$ consumption?

\[ \text{VO}_2 (\text{mL/min}) = 3.5 \text{ L/min} \times 1000 \text{ mL/1L} = 3500 \]
\[ \text{VO}_2 (\text{mL/kg/min}) = \frac{3500 \text{ mL/min}}{70 \text{ kg}} = 50 \]
What are normal values for relative (mL/kg/min) VO$_2$ for various groups of individuals?

Untrained College-aged Females   30-35 mL/kg/min
Untrained College-aged Males   35-45 mL/kg/min

Active College-aged Females   40-45 mL/kg/min
Active College-aged Males   45-50 mL/kg/min

Trained College-aged Females   50-60 mL/kg/min
Trained College-aged Males   55-65 mL/kg/min

Competitive College-aged Males   65-85 mL/kg/min

Highest measured VO$_{2max}$   ~95 mL/kg/min
Why does aerobic exercise training increase VO$_{2\text{max}}$?

Let’s focus on the Fick Equation

$$VO_2 = HR \times SV \times a-vO_{2\text{diff}}$$

Factors to consider are how does training affect:

- HR
- SV
- a-vO$_{2\text{diff}}$

Also, consider this relationship:

$$1 \text{ L/min } VO_2 = 6 \text{ L/min } Q$$

Therefore if…..:

VO$_2$ is 2 L/min, what must Q be?

3 L/min?, 4 L/min?, 5 L/min?
Fick Equation

\[ \text{VO}_2 = \text{HR} \times \text{SV} \times \text{a-vO}_2\text{diff} \]

Now that we have seen the Fick equation how should I relate this to training adaptations? Here are some thoughts and questions to focus your thinking.....

1) What are the training adaptations to resting HR, submax HR and max HR?
   Be able to describe why training changes these. How do changes in HR relate to Q? (Be able to talk about \( Q = \text{HR} \times \text{SV} \))

2) How does training affect SV?
   Be able to describe changes in EDV and ESV. What causes these to change and how do they contribute to increasing SV. Use the relationship \( \text{SV} = \text{EDV} - \text{ESV} \) to discuss these training adaptations.

3) What role does changes in blood volume play in altering Q?

4) Why is a change in \( Q_{\text{max}} \) important for increasing \( \text{VO}_2\text{max} \)?
5) What is the limit for VO$_{2\text{max}}$? Does it have anything to do with blood volume and changes in Q$_{\text{max}}$?

6) Look over Table 9.4 to fully understand the differences between a trained and untrained cardiovascular system.

7) Blood delivery (i.e., O$_2$ delivery) and O$_2$ utilization. How is this limiting to VO$_{2\text{max}}$ and how does training change the limits to VO$_{2\text{max}}$? Use this Fick equation as part of your explanation (Think about Q and a-vO$_{2\text{diff}}$).