

Q2 Describe the production of carbon dioxide in the body (60% of marks). What are the physiological reasons why the PaCO₂ may be high? (40% of marks) (March 2009)

CO₂ production → normally ~ 200ml/hr (compared to average oxygen intake of 250ml/hr)

- Produced in the cell mitochondria as a byproduct of aerobic metabolism via the citric acid cycle
 - Entry of a substrate into the mitochondria in the form of acetyl CoA causes the movement of electrons through a series of enzymatic reactions, eventually forming CO₂, reduced compounds FADH and NADH, and H⁺ ions
 - The final movement of electrons occurs via the reduced compounds through the electron transport chain, eventually forming ATP and H₂O.
 - Every 1 molecule of ATP produced is accompanied by 2 molecules of CO₂
- Respiratory quotient R = CO₂ production / O₂ consumption → depends on fuel substrate (0.7 for fat, 1.0 for CHO), usually about 0.8
- The quantity of carbon dioxide and bicarbonate ion in the body is very large - about 120 litres, which is almost 100 times greater than the volume of oxygen.
- CO₂ is carried in the blood in 3 forms – dissolved (5%), as bicarbonate (70-80%) and as carbamino compounds (20-25%).

High PaCO₂:

- PaCO₂ will be a result of the balance between production and elimination of CO₂
- P_aCO₂ should be very similar to P_ACO₂, which depends on the alveolar ventilation equation: $V_A = (V_{CO_2} / P_ACO_2) \cdot k$, where V_{CO₂} = CO₂ production, V_A = alveolar ventilation, and k is a constant.
- Rearranging, $P_ACO_2 = (V_{CO_2} / V_A) \cdot k$
- Production is described above and may be increased in:
 - Increased metabolic states – fever, malignant hyperthermia, sepsis
 - An increase in the respiratory quotient - higher for CHO than fat, for example, as seen with fast paced exercise
- CO₂ elimination may be decreased with:
 - Hypoventilation (reduction in tidal volume or RR) – fatigue, incomplete reversal of paralysis, spinal cord injury or intracranial cause
 - Increased alveolar dead space - PE, low cardiac output state, PEEP increasing West's zone 1