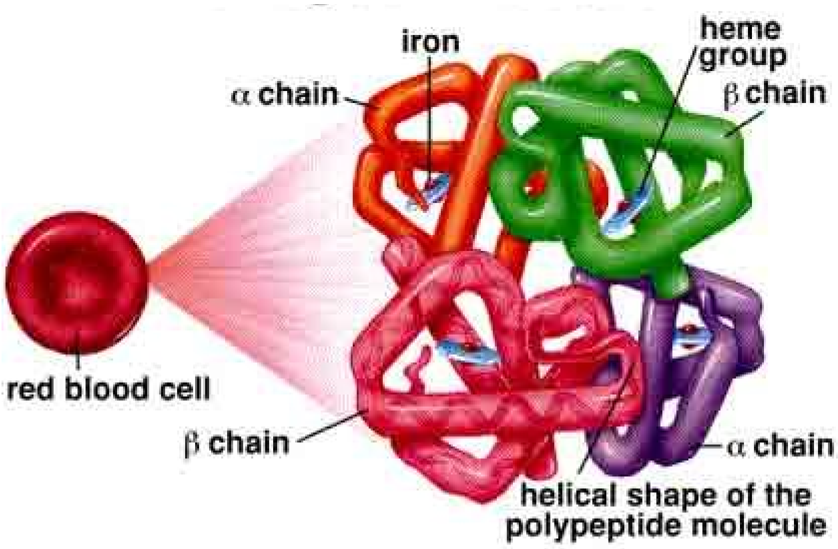
Quarternary structure of Haemoglobin (Fig 1, pg 161)

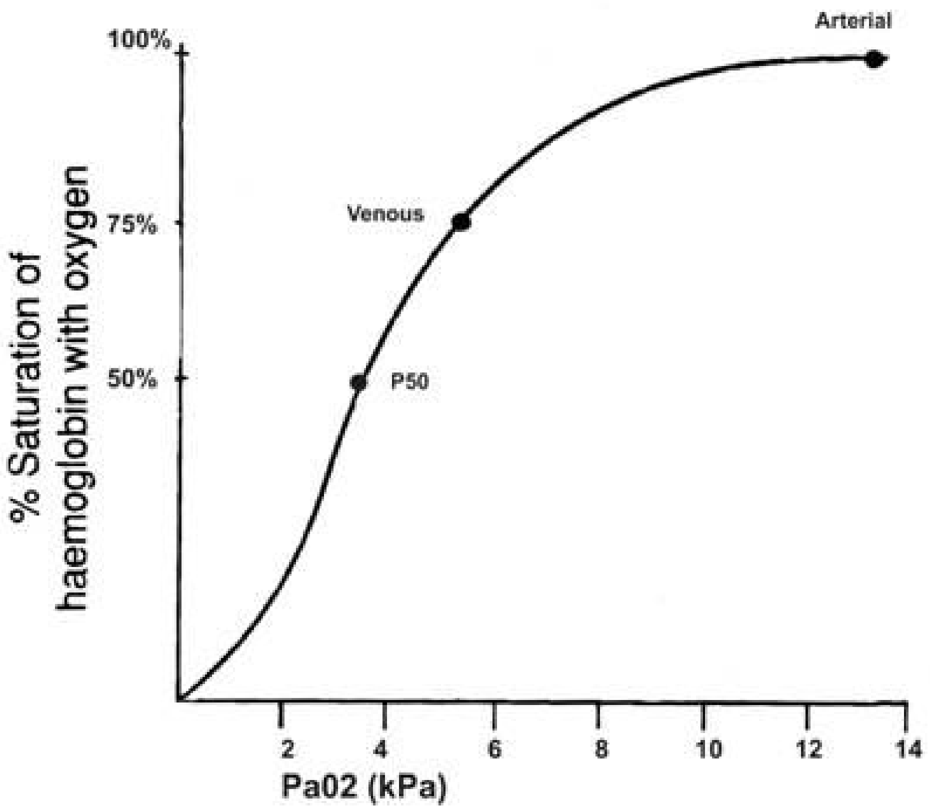


- 4 polypeptide chains
- Each folded into tertiary structure
- Each contains an iron = picks up oxygen

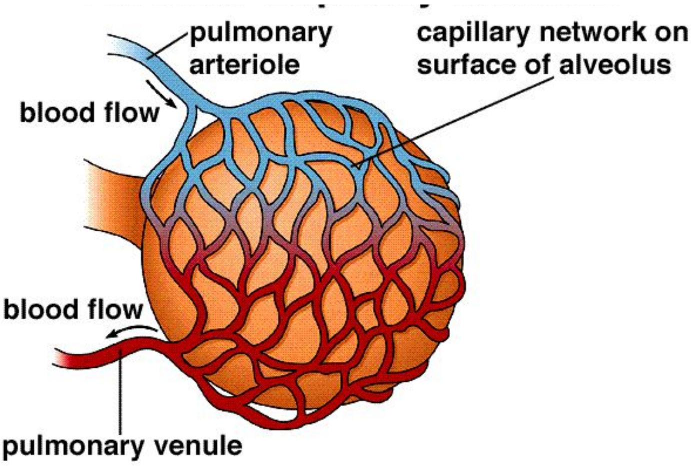
Haemoglobin + $4O_2$ → Oxyhaemoglobin

dark red bright red

Oxygen dissociation curve for haemoglobin



pO2 = concentration of oxgyen in air (partial pressure)



In the lungs, concentration of oxygen in the alveoli is high → O2 diffuses down conc gradient → enters capillaries and is loaded on to RBCs

The oxygenated blood returns to the heart and is pumped around the body.

In the tissues the concentration of oxygen is low → oxygen is unloaded into the tissues, used for respiration

Why is the dissociation curve sigmoid in shape? (pg 163)

- The globular shape and quaternary structure of haemoglobin makes it hard for the first oxygen to bind to haemoglobin

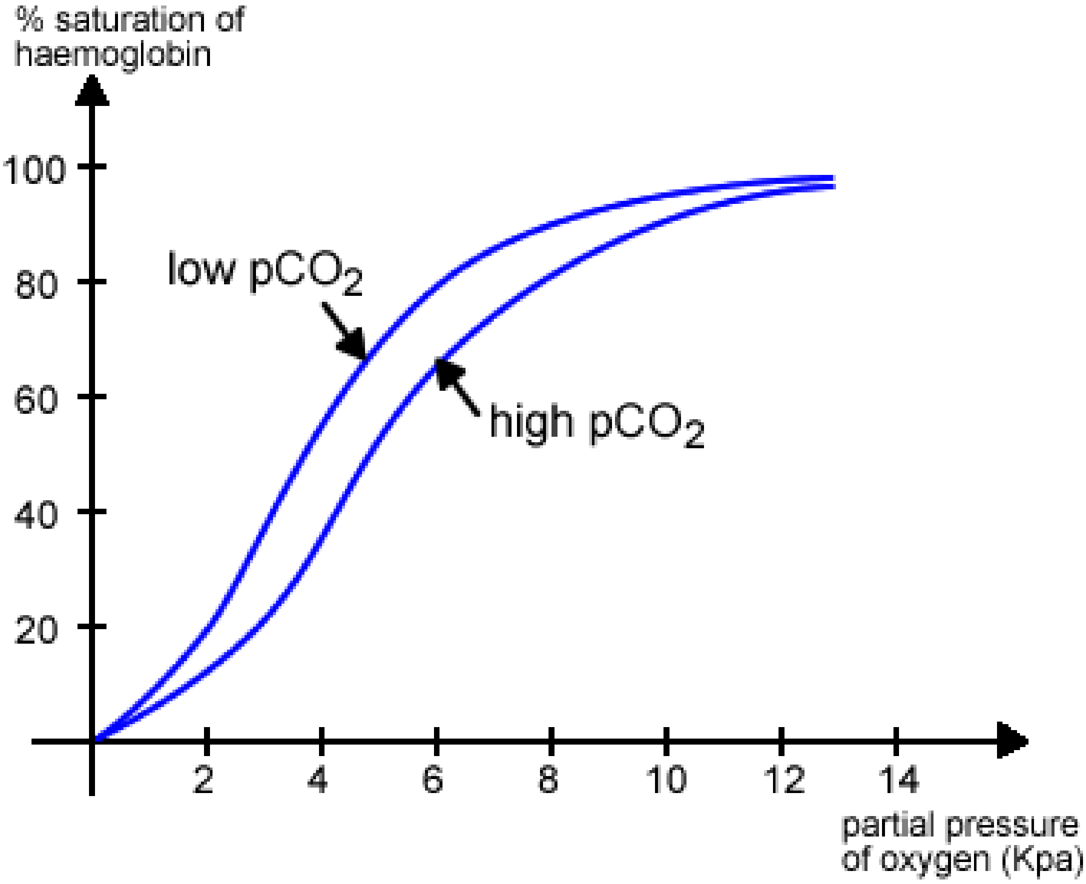
- Therefore, the initial gradient is shallow

- Once the first oxygen molecule binds, it changes the tertiary structure of the other 3 subunits, making it easier for them to bind to oxygen

- Therefore a smaller increase in partial pressure is needed to bind the second (and third) oxygen molecule (positive cooperativity) - the gradient steepens

- the fourth oxygen binds more slowly,due to the reduced probability of finding an empty binding site

Bohr effect (pg 164, Fig 2)



(calculation)

Bohr effect

- In humans (and other organisms), the affinity of haemoglobin can change in response to carbon dioxide levels
- When CO_2 levels in the respiring tissue are high, the oxygen dissociation curve shifts to the right, reducing its affinity for oxygen
- More oxygen is released to respiring tissues

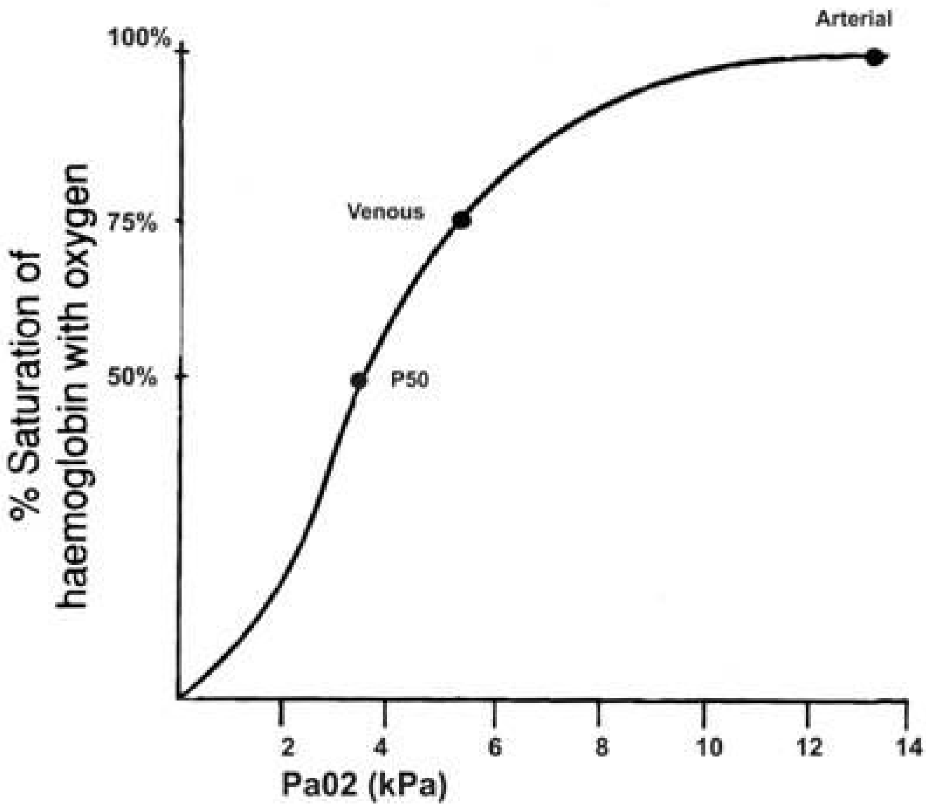
How this happens:
- Increasing levels of CO_2 reduces the pH (more acidic)
- This changes the tertiary structure of haemoglobin, decreasing its affinity for oxygen
- oxygen is more readily released into the tissues

The reverse happens when CO_2 levels are high.

Lactic acid has a similar effect to CO_2 .

This mechanism ensures that oxygen is delivered where it is most needed.

Effect of surface area to volume ratio



Effect of surface area to volume ratio

- as surface area to volume ratio increases, the heat loss from the body surface also increases

- in mammals, heat is generated through aerobic respiration

- which requires oxygen

- therefore oxygen consumption increases

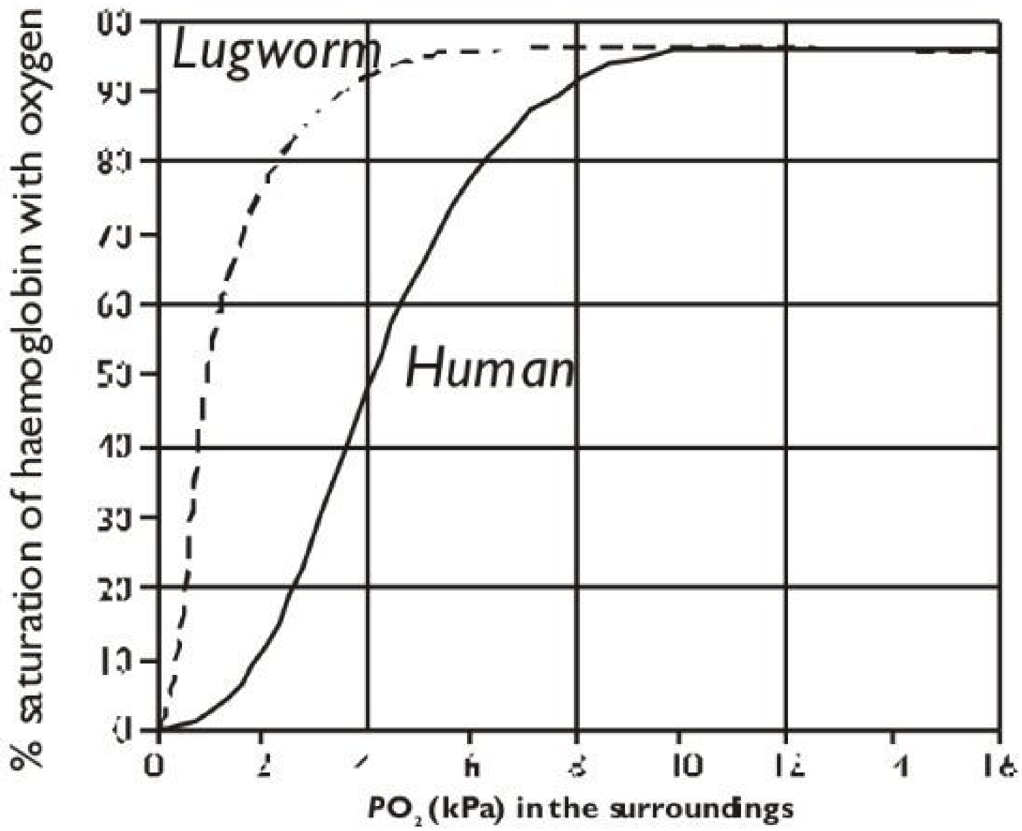
Look at: Pg 167, Fig 7

Mouse would have the highest rate of respiration. The dissociation curve for the mouse is shifted to the right of man and elephant.

This means that it has a lower affinity for oxygen, and releases oxygen more readily to tissues.

Q. use the data from the graph (fig 7) to support your hypothesis

Effect of oxygen availability - Lugworm (pg 165, Fig 4)



- Lugworm lives in sand burrows by the seashore

- oxygen availability is subject to tidal fluctuations

- when the tide is in, oxygen in plentiful

- when the tide is out, there is very little oxygen in the burrow

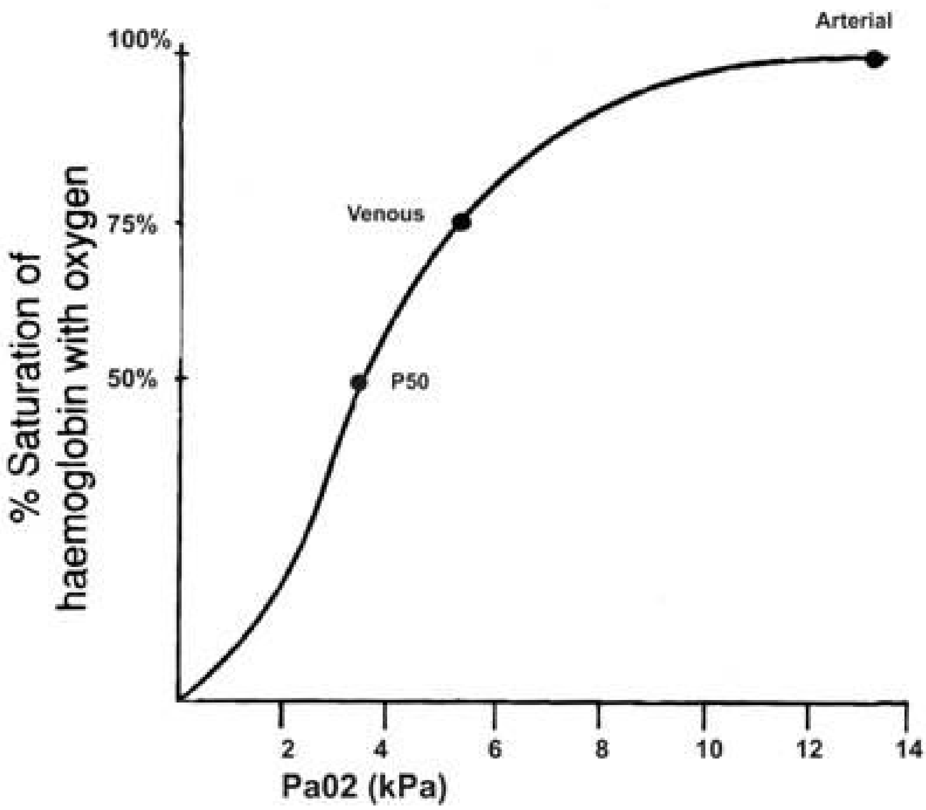
- the dissociation curve is shifted to the far left

- it has a very high affinity for oxygen

- it can extract as much oxygen as possible from the water in the burrow, till the tide comes in again

(also means that less oxygen is released to muscles for respiration and movement)

Effect of oxygen availability - llama



- Llama lives at high altitudes, when the partial pressure of oxygen is lower

- therefore its dissociation curve is shifted to the left of man

- it has a higher affinity for oxygen than human haemoglobin

- however, less is released to tissues

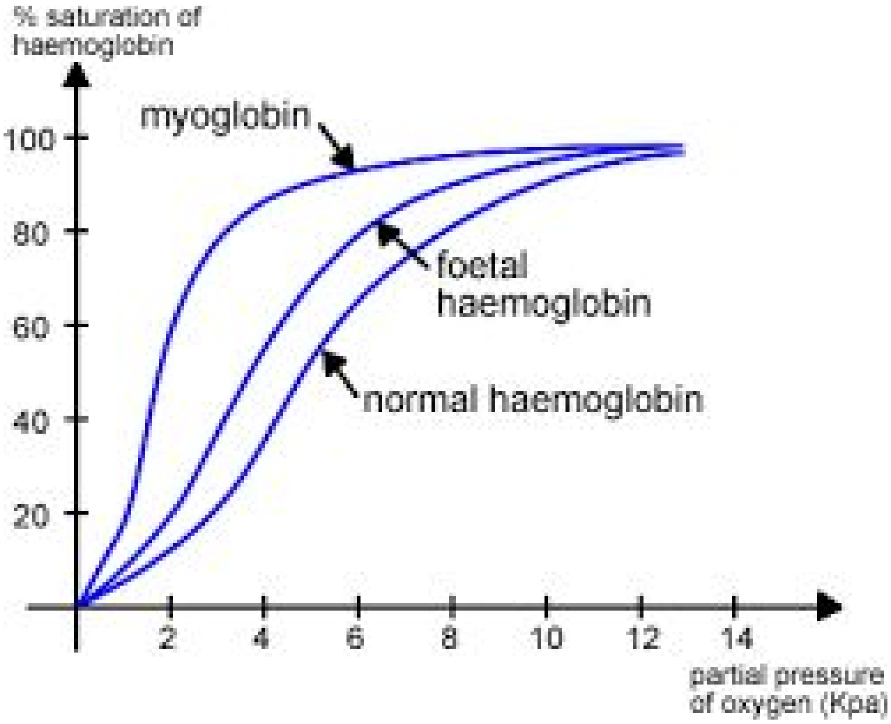
- the llama produces more RBCs to compensate

Q. Elite endurance athletes train at high altitudes for a few weeks before a major race. Explain an advantage of this.
Once they return to sea level, they sleep in low-oxygen tents till the day of the race. Explain an advantage of this.

Applied Questions

Q. pg 166, Qs 2 in 'Acitivity Counts'

Q.



Myoglobin stores oxygen in muscles - why is the curve to the left of human haemoglobin?

Why does foetal haemoglobin have a higher affinity for oxygen than human haemoglobin?