Consider the differences between the O_2 binding properties of Hb and Mb.

The O_2 binding curve for Mb is shown in Fig 7.5. The curve describes the fraction, θ, of molecules that have bound O_2 at various partial pressures of O_2, P_{O_2}.

The relationship between θ and P_{O_2} is determined from the equilibrium expression as shown in the handout.

The fraction of Mb molecules which have bound O_2 can be determined from differences in the absorption spectra of Mb in the presence and absence of O_2 as shown in Fig 9-2.

The shape of the O_2 binding curve is hyperbolic.

P_{50} is the P_{O_2} at which 50% of the Mb has bound O_2.

Fig 7.8(a) shows that the O_2 binding properties of Mb would not provide efficient transport of O_2 from the lungs to tissues.

The partial pressure of O_2 in the lungs is about 3 times that in the tissues (~ 100mm Hg compared to 30mm Hg) as shown in Fig 7.8(a).

Mb would not provide efficient O_2 transport because at both these pressures most of the protein would be in the bound form, i.e., Mb would not release a significant fraction of its bound O_2.

The binding curve for Hb is sigmoidal as shown in Fig 7.8(d).

The binding curve is sigmoidal because O_2 binding is cooperative.

By cooperative, we mean that the binding of O_2 to the heme Fe in one subunit affects the binding affinity (K) of the other subunits.

In Hb, there is a progressive increase in the affinity of unbound subunits as the number of O_2 bound subunits increase.

Because of cooperative binding, Hb will be almost fully saturated ($\theta \approx 1$) with O_2 at 100mm Hg but only partially saturated ($\theta \sim .4$) with O_2 at 30mm Hg.

Therefore most of the O_2 bound by Hb in the lungs will be released by Hb at the tissues.

Fig 7.10 is a Hill plot of O_2 binding to Hb and Mb. In the Hill plot the log of the ratio of O_2 bound sites/unbound sites is plotted versus the log P_{O_2}.

For Mb, the plot is a straight line with a slope of 1.

For Hb, the plot is not linear, but the maximum slope is a measure of the cooperativety of binding, i.e., the greater the slope the more cooperative the binding.

Consider how the binding of O_2 to the heme Fe in one subunit affects the affinity of O_2 binding to the other subunits.

X-ray crystal studies indicate that there are differences in the structures of oxyHb and deoxyHb.

Fig 7.13 is an attempt to show the change in structure as O_2 is bound to Hb.

Figs 7.17 and 7.16 show the basis for the change.

The structure of deoxyHb is referred to as the T (tensed) state while the structure of oxyHb is referred to as the R (relaxed) state.

In the T state, the structure at the heme is not as conducive to O_2 binding because of the orientation of the proximal His and the neighboring Val FG5 as shown in Fig 7.17.