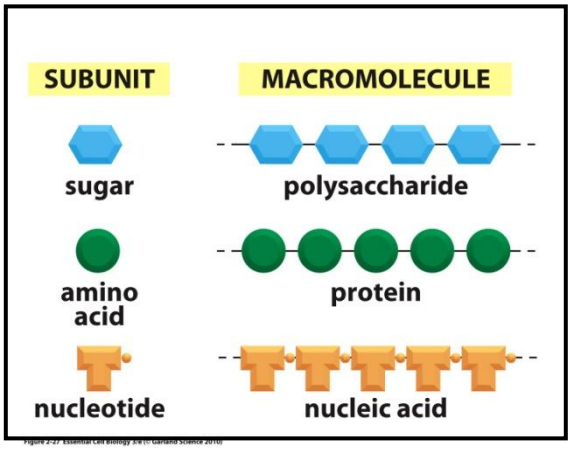
Assignment 3 due Friday October 2 2009

Alberts et al Ch 4:119- 149 and handouts

I. At right is figure 2-27 from your text book; it illustrates the similarity in some of the macromolecules that we have talked about in that they each consist of monomers covalently linked into polymers. Two important differences are not shown in this figure:



a) First, only one of these three polymers can be "branched" (for example where one subunit is attached to three other subunits) while the other two are strictly linear (each subunit is attached to only two other subunits). Which is the polymer that can be branched?

b) Second, nucleotide polymers (especially DNA) are generally FAR longer than the polymers of amino acids or sugars. Although it's a little unfair to talk about the "length" of a protein (why?)
let's go ahead and use some math to think about these:
Please fill out the empty squares (you can round off your answers to two significant figures) .
Note that 1 A^o = 10^{-10}m

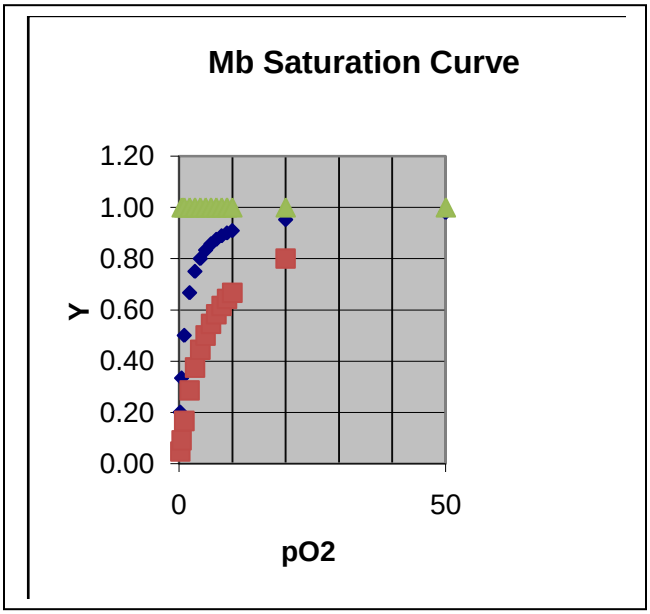
molecule	number of subunits	"length" of each subunit	total "length" (in A^o)	total "length" in meters	total "length" in mm
beta globin protein	147 a.a.	3.6 A^o			
dystrophin protein (the largest characterized human protein)	3684 a.a.!	3.6 A^o			
beta globin gene	1600 nucleotides	3.4 A^o			
DNA molecule of chromosome #I (human) (yes, this is ONE molecule of DNA)	224 million nucleotides (our largest chromosome)	3.4 A^o			

II. Below is a graph of the hierarchies of protein folding with 16 slots. Slide these sixteen words or phrases into those slots: amide-carbonyl hydrogen bond, amino terminus, $\alpha_2\beta_2$, α-helix , β sheet, blood clotting, carboxy terminus, cooperativity, disulfide bonds, globin fold, hydrophobic core, R->T transition, right off the ribosome, sequence, turn, van der Waals packing

PRIMARY	SECONDARY	TERTIARY	QUARTENARY

III. Myoglobin Binding – EXCEL File online on CMS

1. Which represents stronger binding, Kd = 5 mM or Kd=1 mM? Explain



2. How does Y change as pO2 increases?

3. What happens to Y when Kd increases?

4. What is special about Y = 0.5?

5. Enter your own Kd into the spreadsheet in the appropriate place (see ENTER YOUR OWN KD here) and see how it affects the binding. Print out the graph and hand it in with your HW.

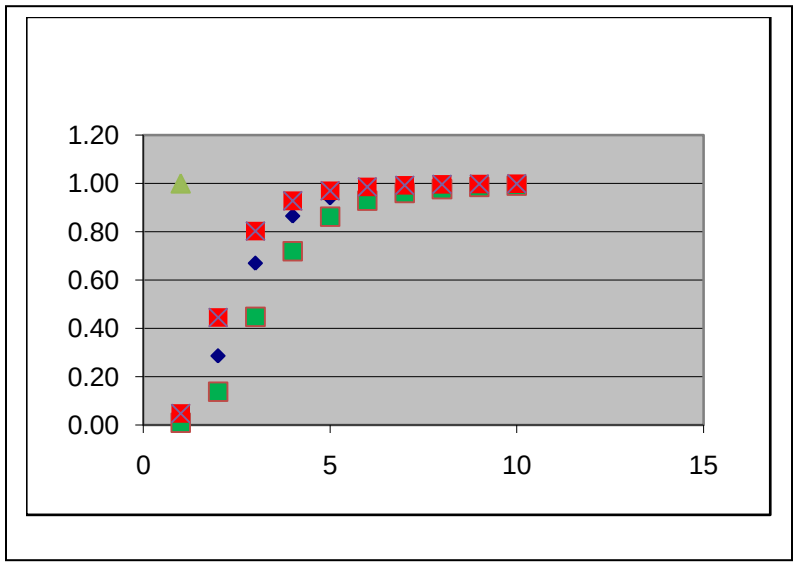
IV. Hemoglobin Binding –EXCEL File online at CMS

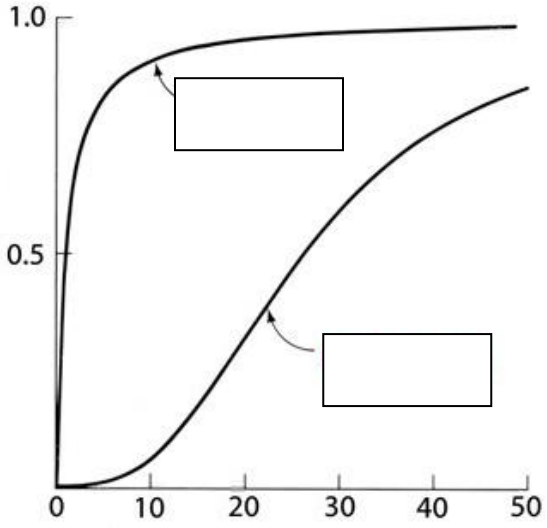
1. How do these curves differ from the binding curves for myoglobin?

2. At what approximate pO_2 will the Hb be 50% saturated for Kd=20 (red), 40 (blue), and 100 (green) mM?

3. When Hb is 50% saturated, what does that mean in terms of molecular species present (i.e. 50% apo and 50% $Hb(O_2)_4$ or something else)?

4. What must be the relative values of the Kd of Mb and Hb to make sure that the transfer goes in the right direction (i.e. Hb to Mb and not the other way)? Explain





V. Shown at left are binding curves similar to those we have seen in class.

1. Label the x and y axes directly on the graphs. Include units if appropriate.

2. Next, indicate in the boxes which curve is Myoglobin and which curve is Hemoglobin.

3. When the value for Y = 0.5, what does that mean about the binding in Mb? .....in the Hb tetramer?

Mb: _____

Hb: _____

4. What is the significance of the x value for each curve at the point where y = 0.5?

5. What is it about the functions of the two proteins that require a difference in the saturation curves?

6. Please fill in the blanks:

I am the small molecule that binds in the center of the Hb molecule and stabilizes the T state. Without me, the Hb binding curve looks just like the Mb binding curve.

Who am I? _____

I am the atom in both Hb and Mb that bonds directly to the O_2 molecule and holds it in place in the protein. Who am I? _____

I am the non-protein group that contains the atom that makes a bond to the O_2 molecule. Who am I? _____

I am the amino acid that bonds with the atom that binds to the O_2 molecule (name but not number). Who am I?_____

I am the product of cellular respiration that is exhaled by the lungs and is carried on the C-terminal carboxylic acids of Hb and as bicarbonate anion by the blood. Who am I? _____

I am the atom that is able to shift the binding curve of Hb to the right and cause more oxygen to be delivered to the tissue in times of extreme exercise. I have many binding sites on the Hb molecule. Who am I? _____

I am the state of Hb (R or T) in which binding of O_2 is at its best, and to which H^+, DPG, CO_2 do NOT bind very well. Who am I? _____