MCB 102 Quiz #2 Answer Key
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1. **Hemoglobin and myoglobin share some important structural and functional traits, but they also differ in important ways. Give 5 examples of structural and/or functional properties that they share or do not share. (5 pts)**

   Ans:
   Share:
   Both have heme group that binds oxygen; globular proteins with dense hydrophobic cores; Mb and each subunit of Hb have very similar tertiary structure; hemes are buried deep in the protein to prevent oxidation of Fe2+ to Fe3+; both have many alpha-helices; both bind CO

   Different:
   Mb: has one subunit and thus does not show allosteric cooperative binding; has higher affinity for O2 and insensitive to small changes in pO2; has hyperbolic O2-binding curve; acts as a O2 storage molecule in the muscles and facilitates O2 diffusion in rapidly contracting muscles with very low pO2; very different primary structure; nH=1;

   Hb: is tetrameric with 4 subunits, each with its own heme group; shows cooperative binding between the subunits and transitions from T to R states; sigmoidal O2-binding curve; sensitive to small changes in pO2 and thus acts as a O2 transport protein, binding O2 efficiently in the lungs and releasing it in the tissues; nH=3; binds H+, CO2, and 2,3-BPG, each of which decreases binding affinity; various types of Hb with different subunits (ie HbA, HbF, HbS

2. **A) Using the Oxygen-binding curve to illustrate your points, explain the Bohr Effect. (Make sure you label your axes!) (3 pts)**

   Ans: See page 171 for the graph. The Bohr Effect refers to the effect of pH and CO2 concentration on O2 binding affinity of Hb. Increased concentrations of H+ (decreased pH) and CO2 result in decreased binding affinity, shifting the curve to the right (i.e., need higher pO2 to achieve the same theta).

   B) What is the mechanism of this effect and which substance(s) are involved? (3 pts)

   Ans: H+ and CO2. H+ binds to various amino acids on Hb (ie His 146), which, when protonated, form ion pairs that help stabilize the T state. CO2 binds at the N-terminal of each globin chain, forming salt bridges to stabilize T state. CO2 binding also releases more H+, which increases the effect.

   C) What is the functional significance of this effect? (2 pts)
   At low pH and high pCO2 (i.e. the tissues), the affinity of Hb for O2 is decreased, promoting its release into the tissues. In the lungs at higher pH and lower pCO2, CO2 is excreted and O2

affinity increases. This allows for efficient transport of O2 into the tissues and CO2 to the lungs.

3**. The most important contribution to the stability of a protein's conformation appears to be the: (Ans: A)**

A) Entropy increase from the decrease in ordered water molecules forming a solvent shell around it.
B) Maximum entropy increase from ionic interactions between the ionized amino acids in a protein.
C) Sum of free energies of formation of many weak interactions among the hundreds of amino acids in a protein.
D) Sum of free energies of formation of many weak interactions between its polar amino acids and surrounding water.
E) tabilizing effect of hydrogen bonding between the carbonyl group of one peptide bond and the amino group of another.

4.

A) Draw the backbone arrangement of a polypeptide. (1 pt)
B) Indicate which of the bonds show free rotation and include the resonance structure. (3 pts)

Ans: See page 119. Cα-N (ϕ bond angle) and Cα-C (φ bond angle) rotate.

C) Name a peptide that is likely to have a relatively high number of allowed pi and psi configurations, and one that is likely to have relatively less. (2 pts)

Ans: Most: Gly
More: Ala
Less: Val, Ile, Thr (branched, more steric hindrance)
Least: Pro (ϕ greatly limited by cyclic side chain)

5. The major reason that antiparallel b-stranded protein structures are more stable than parallel b-stranded structures is that the latter: (2 pt Bonus Question) (E)

A) Are in a slightly less extended configuration than antiparallel strands.
B) Do not have as many disulfide crosslinks between adjacent strands.
C) Do not stack in sheets as well as antiparallel strands.
D) Have fewer lateral hydrogen bonds than antiparallel strands.
E) Have weaker hydrogen bonds laterally between adjacent strands.

6. What is the concept of "induced fit" as it applies to antigen-antibody binding? (2 pts)

Ans: The conformations of the antigen and antigen-binding site of the antibody are influenced by each other and change as binding occurs. These conformational changes increase the chemical complementarity of the sites and result in tighter binding.

7. Which one of the following statements is true of enzyme catalysts? (2 pts) (D)

A) Their catalytic activity is independent of pH.
B) They are generally equally active on D and L isomers of a given substrate.

C) They can increase the equilibrium constant for a given reaction by a thousand fold or more.
D) They can increase the reaction rate for a given reaction by a thousand fold or more.
E) To be effective, they must be present at the same concentration as their substrate.