Quiz 2 Answer Key

1. In the α helix the hydrogen bonds: (1pt) **Ans: A**

    A) are roughly parallel to the axis of the helix.
    B) are roughly perpendicular to the axis of the helix.
    C) occur mainly between electronegative atoms of the R groups.
    D) occur only between some of the amino acids of the helix.
    E) occur only near the amino and carboxyl termini of the helix.

1. In an α helix, the R groups on the amino acid residues: (1pt) **Ans: B**

    A) alternate between the outside and the inside of the helix.
    B) are found on the outside of the helix spiral.
    C) cause only right-handed helices to form.
    D) generate the hydrogen bonds that form the helix.
    E) stack within the interior of the helix.

2. Why are glycine and proline often found within a β turn? (1pt)

    Ans: A β turn results in a tight 180° reversal in the direction of the polypeptide chain. Glycine is the smallest and thus most flexible amino acid, and proline can readily assume the cis configuration, which facilitates a tight turn.

2. What are two mechanisms by which "chaperone" proteins assist in the correct folding of polypeptides?

    Ans: Chaperones protect unfolded polypeptides from aggregation by binding to hydrophobic regions. They can also provide a microenvironment that promotes correct folding.

3. What effect does a drop in the pH of blood plasma from 7.4 to 7.2 have on the O_2 affinity of myoglobin and hemoglobin? (1pt)

    Ans: Myoglobin is not affected by a change in pH. A reduction in pH (increase in H+) would result in a decrease in the affinity of hemoglobin for oxygen.

3. What effect does a decrease in partial pressure of CO_2 in the lungs from 6kPa (holding one's breath) to 2kPa (normal) have on the O_2 affinity of myoglobin and hemoglobin? (1pt)

    Ans: Myoglobin is not affected. This would result in an increase in the O_2 affinity of hemoglobin.

4. Chymotrypsin belongs to a group of proteolytic enzymes called the "serine proteases," many of which have an Asp, His, and Ser residue that are crucial to the catalytic mechanism. The serine hydroxyl functions as a nucleophile. What do the other two amino acids do to support this nucleophilic reaction? (1pt)

    Ans: In chymotrypsin, histidine functions as a general base, accepting a proton from the serine hydroxyl, thereby increasing serine's reactivity as a nucleophile. The negatively charged Asp stabilizes the positive charge that develops on the His.

4. For serine to work effectively as a nucleophile in covalent catalysis in chymotrypsin a nearby amino acid, histidine, must serve as general base catalyst. Briefly describe, in words, how these two amino acids work together. (1pt)

Ans: The serine is a polar hydroxyl, with the oxygen functioning as an electronegative nucleophile. A nearby histidine residue, with $pK_a \approx 6.0$, however, functions as a base to abstract the proton from the serine hydroxyl group. The result is to substantially increase the electronegativity of the serine oxygen, making it a much stronger nucleophile. This, in turn, lowers the activation energy of the covalent catalysis between serine and the carbonyl carbon of the substrate peptide bond. (See Fig. 6-21, pages 216-217.)

5. The turnover number for an enzyme is known to be 5,000 min^{-1}. From the following set of data, calculate the K_m and the total amount of enzyme present in these experiments. (1pt)

Substrate concentration (mM)	Initial velocity (μmol/min)
1	167
2	250
4	334
6	376
100	498
1,000	499

(a) K_m = __________. (b) Total enzyme = __________ μmol.

Ans: K_m = about 2 mM (the concentration of S needed to achieve one-half of V_{max}, which is about 500). The total enzyme present is producing about 500 μmol of product per minute. Because the turnover number is 5,000/min, the amount of enzyme present must be 0.1 μmol; 1 μmol of enzyme would produce 5,000 μmol product/min.

6. An enzyme catalyzed a reaction at a velocity of 32 μmoles/liter-minute when the concentration of its substrate was 0.02 M. The K_m of the enzyme for this substrate is 4×10^{-5} M. What would the initial velocity be at the following substrate concentrations? (a) 3.8×10^{-3} M; (b) 4.2×10^{-4} M (1pt)

For an enzyme-catalyzed reaction: $E + S \rightleftarrows ES \rightarrow E + P$

Using Michaelis-Menten equation, we can get $V_0 = \frac{V_{max} \cdot [S]}{[S] + K_m}$

In this case, $K_m = 4\times10^{-5}$M, [S] =0.02M, V_0=32μmoles/L-min.
Since $[S] >> K_m$, $V_{max} = V_0$ = 32 μmoles/L-min.

$$V_0 = \frac{V_{max} \cdot [S]}{[S] + K_m} = 32 \cdot [S] / [S] + 4\times10^{-5} (\mu moles/L\text{-}min)$$

a) 31.7 μmoles/L-min
b) 29.2 μmoles/L-min