

Chem 464 Biochemistry

Multiple choice (4 points apiece):

1. In the binding of oxygen to myoglobin, the relationship between the concentration of oxygen and the fraction of binding sites occupied can best be described as:

- A) linear with a negative slope.
- B) linear with a positive slope.
- C) random.
- D) sigmoidal
- E) hyperbolic.

2. Which one of the following statements is true of enzyme catalysts?

- A) They increase the equilibrium constant for a reaction, thus favoring product formation.
- B) They increase the stability of the product of a desired reaction by allowing ionizations, resonance, and isomerizations not normally available to substrates.
- C) They lower the activation energy for the conversion of substrate to product.
- D) To be effective they must be present at the same concentration as their substrates.
- E) They bind to substrates, but are never covalently attached to substrate or product.

3. The steady state assumption, as applied to enzyme kinetics, implies:

- A) the enzyme is regulated.
- B) the ES complex is formed and broken down at equivalent rates.
- C) the K_m is equivalent to the cellular substrate concentration.
- D) the maximum velocity occurs when the enzyme is saturated.
- E) $K_m = K_s$.

4. Which of following is an anomeric pair?

- A) D-glucose and L-fructose
- B) D-glucose and L-glucose
- C) α -D-glucose and β -D-glucose
- D) α -D-glucose and β -L-glucose
- E) D-glucose and D-fructose

5. The biochemical property of lectins that is the basis for most of their biological effects is their ability to bind to:

- A) specific peptides.
- B) amphipathic molecules.
- C) hydrophobic molecules.
- D) specific lipids.
- E) specific oligosaccharides.

6. The difference between a ribonucleotide and a deoxyribonucleotide is:
- A) a ribonucleotide is a pyranose, deoxyribonucleotide is a furanose
 - B) a deoxyribonucleotide has an —H instead of an —OH at C-2.
 - C) a deoxyribonucleotide has α configuration; ribonucleotide has the β configuration a C-1.
 - D) a ribonucleotide has an extra —OH at C-4.
 - E) a ribonucleotide has more structural flexibility than deoxyribonucleotide.
7. In living cells, nucleotides and their derivatives can serve as:
- A) carriers of metabolic energy.
 - B) enzyme cofactors.
 - C) intracellular signals.
 - D) precursors for nucleic acid synthesis.
 - E) all of the above.

Short Answer (10 points each)

8. What is BPG and how is it important in your bodies adaptation to living at high altitude?

BPG stands for 2,3-Bisphosphoglycerate. This compound is found in red blood cells at a concentration of about 5 mM. At high altitudes this concentration increases to about 8mM. BPG binds to hemoglobin in a cavity between the β subunits and stabilizes the 'T' state, thus lowering the affinity of the hemoglobin molecule for oxygen. This decrease in O_2 affinity makes the hemoglobin give off oxygen more readily and is part of your bodies adjustment to living at high altitude

9. Define the following terms and explain how they can be used by an enzyme to increase the rate of a reaction

- Acid-Base catalysis
- Covalent catalysis
- Metal ion catalysis

Acid-Base catalysis - when charges in an unstabilized charged intermediate in a reaction are stabilized by either H^+ or OH^- (specific Acid-Base catalysis) or by protonated basic or deprotonated acidic anions (general acid-Base catalysis). This can also refer to the moving of electrons back and forth in intermediates due to interactions with electron pairs in Lewis acids and bases

Covalent Catalysis when a transient covalent bond is formed between the enzyme and the substrate. The formation of this covalent intermediate provides a new low energy pathway for the reaction to take, thus speeding up the reaction rate

Metal Ion Catalysis - Any time an enzyme uses a metal ion as part of a catalytic mechanism. May be used to stabilize charge, to form a covalent intermediate, or as a Lewis acid or base

10. One of the ways of analyzing enzyme kinetics is to plot $1/v_o$ vs $1/[S]$. Make a sketch of a plot like this and determine K_m and V_{max} from the data in your plot.

Plot like Figure 1 box 6-1. Slope gives K_m/V_{max} , Y intercept is $1/V_{max}$, X intercept is $-1/K_m$

If you showed these equations, fine, but I was looking for a plot with numbers along X and Y axes, and K_m and V_{max} values derived from your hypothetical plot

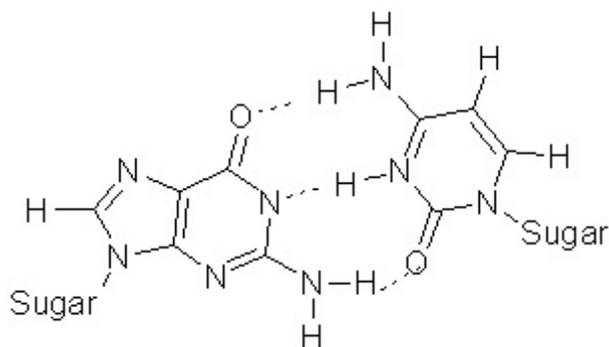
11. Compare and contrast the structure of cellulose and chitin

Cellulose and chitin structures are based on the same ($\beta 1-4$) linkage. In cellulose this is between glucose molecules, and in chitin this is between N-acetyl-D-glucosamine sugars. In both of these structures the β linkage between the sugars makes it so the sugars make strong hydrogen bonding to each other and not to the solvent to form long polymers that do not interact with water, and are almost completely insoluble at neutral pH.

12. Briefly discuss glycoproteins, include relative size of protein and carbohydrate, where any why they are used in an organism, some example molecules and some observed structural features.

Glycoproteins are proteins that have carbohydrates attached, but the amount of carbohydrate is always less than the amount of protein. The carbohydrate is linked to the protein with through the O of Ser or Thr, or the N of Asn. Rather than the long , highly repetitive, linear sugars seen in proteoglycans, the sugars of carbohydrates are much more diverse and tend to have several branches close to the protein. The reason for carbohydrate attachment is not completely clear, but it does seem to stabilize the protein outside of the cell, and also seems to be a recognition marker for the protein and the organism.

13. Sketch the structure of C hydrogen-bonded to G



14. What is Hoogsteen base pairing and how does it relate to DNA structure.

A Hoogsteen base pair is an alternative base pairing that can be used to associate DNA bases in different ways than seen in the Watson-Crick base pairs. These alternate base pairing schemes can be used to form bind three or even four different strands of DNA into a single structure or can be used to stabilize some of the complex 3-D structures observed in RNA's

Alternate question for those who did the assigned problems. Can be substituted for any 10 point question.

When enzyme solutions are heated there is a progressive loss of catalytic activity over time due to the denaturation of the enzyme. A solution of the enzyme hexokinase incubated at 45°C lost 50% of its activity in 12 minutes, but when incubated in a very large concentration of one of its substrates, it only lost 3% of its activity in 12 minutes. Suggest why thermal denaturation of hexokinase is retarded in the presence of one of its substrates

Apparently the binding of the substrate stabilizes the structure of the protein thus the enzyme substrate complex is more stable than the enzyme alone. This allows you to heat the complex to a higher temperature in the presence of the substrate.