

NAME \_\_\_\_\_

**MMBB 300 - Fall 2002**

**EXAM II**

**You may not use a calculator for this exam. Good Luck!**

**Help yourself to substrates at the front of the class**

<b>Page</b>	<b>Points Possible</b>	<b>Points</b>
<b>1</b>	<b>10</b>	
<b>2</b>	<b>12</b>	
<b>3</b>	<b>12</b>	
<b>4</b>	<b>11</b>	
<b>5</b>	<b>14</b>	
<b>6</b>	<b>11</b>	
<b>7</b>	<b>13</b>	
<b>8</b>	<b>12</b>	
<b>9</b>	<b>5</b>	
<b>Bonus</b>	<b>4</b>	
<b>Total</b>	<b>100</b>	

(3 pts)

- 1) **A continuous alpha helix of 12 amino acids is best described as an example of**
- primary protein structure**
  - secondary protein structure**
  - tertiary protein structure**
  - quaternary protein structure**
  - all of the above**

(3 pts)

- 2) **In a continuous alpha-helix that contains 12 amino acids, residue (amino acid) number 10 will most likely be hydrogen bonded to:**
- residue #1**
  - residue #3**
  - residue #6**
  - an amino acid outside of the alpha-helix**

**Alternatively, draw a portion of an alpha-helix which shows one of the hydrogen bonds.**

(4 pts)

- 3) **Describe beta-pleated sheet structure. How is this structure stabilized?**

(3 pts)

- 4) Which pair of amino acids are often found in beta-turns?
- a. Cys and Ala
  - b. Gly and Pro
  - c. Phe and Ala
  - d. Cys and Pro

(3 pts)

- 5) Which of the following is false regarding disulfide bonds?
- a. they can be broken with beta-mercaptoethanol
  - b. they help maintain the folded structure of polypeptides
  - c. they can be broken with urea
  - d. they can cross-link two separate polypeptide chains

(3 pts)

- 6) Which of the following is false regarding the heme group?
- a. heme is considered a prosthetic group
  - b. heme only binds  $\text{Fe}^{2+}$ , not  $\text{Fe}^0$  or  $\text{Fe}^{3+}$
  - c. heme is mostly hydrophobic (except for the iron ion and 2 carboxylate groups)
  - d. heme sits inside a crevice of myoglobin

(3 pts)

- 7) Which of the following is false regarding the crystal structure of myoglobin?
- a. the interior consists of ~equal amounts of hydrophobic & hydrophilic amino acids
  - b. it contains several alpha-helices but has no beta-sheet structure
  - c. the structure proved that polypeptide units are planar
  - d. the crystal structure of myoglobin was solved before that of hemoglobin

(4 pts)

**8) Which of the following is considered biologically inactive?**

- a. deoxymyoglobin**
- b. oxymyoglobin**
- c. ferrimyoglobin**

(5 pts)

**9) Describe the role of the distal histidine in hemoglobin? *Limit your answer to 35 words.***

(4 pts)

**10) Briefly (30 words or less) compare the 3 D structures and amino acid sequences of myoglobin and the alpha subunit of hemoglobin.**

**a. amino acid sequence:**

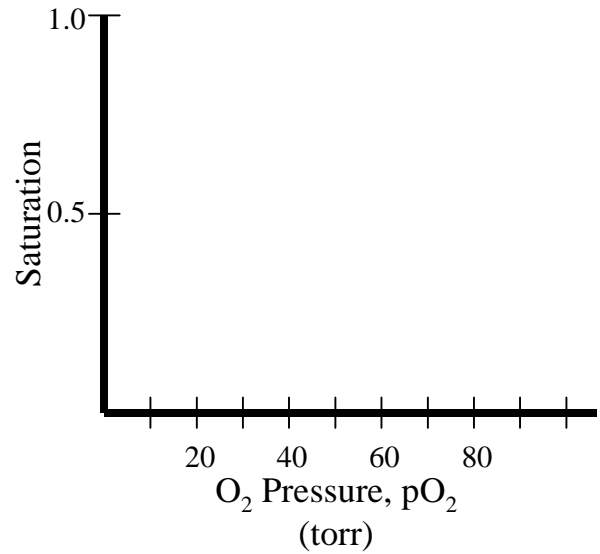
**b. 3D structure:**

(3 pts)

- 11) Which of the following exerts an allosteric effect on the binding of O<sub>2</sub> to hemoglobin?
- a. CO<sub>2</sub>
  - b. H<sup>+</sup>
  - c. organic phosphates such as 2,3-bisphosphoglycerate
  - d. all of the above

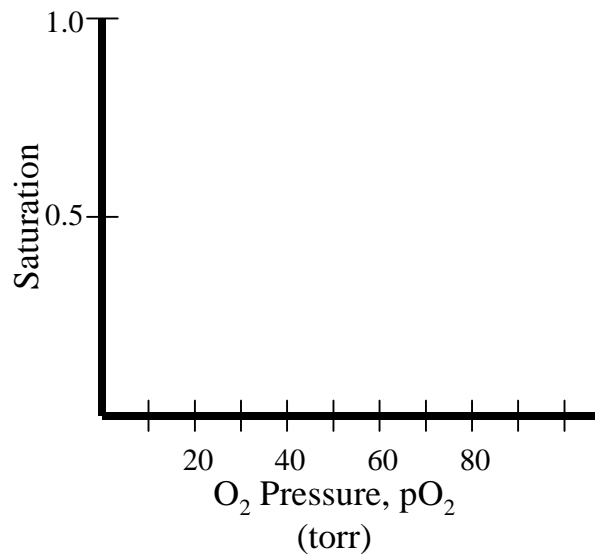
(4 pts)

- 12) Using this diagram, carefully illustrate the binding of O<sub>2</sub> to both myoglobin and hemoglobin



(4 pts)

- 13) Using this diagram, carefully illustrate how pH affects the binding of O<sub>2</sub> to hemoglobin.



This effect is named after: \_\_\_\_\_

(6 pts)

**14) Sickle cell anemia was the first genetic disease characterized at the molecular level.**

**a. What causes the sickle cell hemoglobin to polymerize when  $pO_2$  is low?**

**b. Sickle cell anemia can act as a defense against what disease?**

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(4 pts)

**15) Which of the following regarding prions is false?**

**a. prions are infectious proteins**

**b. prions hijack the RNA & protein synthesis machinery to make more copies of itself**

**c. infectious prions convert uninfected prions to an infectious form**

**d. mad cow disease is caused by prions**

**e. chronic wasting disease is caused by prions**

(4 pts)

**16) True or False**

\_\_\_\_\_ **Enzymes speed up reactions in the forward direction more than the reverse**

\_\_\_\_\_ **Enzymes do not affect the equilibrium concentrations of a reaction**

\_\_\_\_\_ **Enzymes alter the Gibbs' Free Energy of a reaction to make it more favorable**

\_\_\_\_\_ **The Gibbs' Free Energy of activation is unaffected by substrate concentration**

(4 pts)

**17) Using a free energy diagram, carefully illustrate how an enzyme/catalyst can affect a chemical reaction.**

(3 pts)

**18) Which of the following statements regarding common features of enzyme active sites is false?**

- a. H<sub>2</sub>O is usually excluded from the active site**
- b. the active site takes up a relatively small volume of the protein**
- c. the active site is formed by amino acids that can be very far from one another in the primary sequence**
- d. substrates are typically bound to active site amino acids by covalent bonds**

(4 pts)

**19) Briefly explain Dan Koshland's "Induced Fit Model." Limit to 35 words.**

**This replaced which classic model? \_\_\_\_\_**

(4 pts)

20) The following reaction is an example of which enzyme type?



- a. oxidoreductase
- b. transferase
- c. hydrolase
- d. lyase
- e. isomerase

(6 pts)

21) a. Provide the Michaelis-Menten equation.

b. Define  $K_M$

(3 pts)

22) For a given enzyme, the  $K_M$  is determined to be 1.0 mM. At a substrate concentration of 2.0 mM, the initial rate of the reaction would be:

- a. 0.00 %  $V_{\max}$
- b. 33 %  $V_{\max}$
- c. 50 %  $V_{\max}$
- d. 67 %  $V_{\max}$
- e. 100 %  $V_{\max}$

(3 pts)

23) Michaelis-Menten kinetics requires two important assumptions. *Briefly define only one of these assumptions.*

a. The initial rate assumption:

b. The steady state assumption:

(9 pts)

24) a. Using this diagram, carefully illustrate a Lineweaver-Burk plot of a well-behaved enzyme. Label each axis & indicate the value of each axis intercept.

b. Illustrate how a competitive inhibitor would affect this plot.

c. Does this inhibitor affect the  $K_M$  or the  $V_{max}$  or both?

d. If the  $K_M$  for this enzyme (no inhibitor) is 2.0 mM and the substrate concentration is 2.0 mM, what fraction of the enzyme sites are filled with substrate?

(5 pts)

**25) Write a question complete with correct answer; the question needs to come from either the protein special topics lecture or the protein folding reading assignment but it can not be the same as a question already addressed in this exam. Something short like True/False questions will require multiple questions for full credit.**

**(4 pts)**

**Bonus Question: Choose only one of the two options for the Bonus question.**

**Option 1) Identify the following people:**

**a. a-helix and b-sheet structures were first predicted by:**

\_\_\_\_\_ and \_\_\_\_\_

**b. the first two protein structures that were solved (using X-ray crystallography) were:**

\_\_\_\_\_ and \_\_\_\_\_

**c. sickle cell anemia was identified as a “molecular disease” by:**

\_\_\_\_\_

**the actual mutation causing sickle cell anemia was identified by:**

\_\_\_\_\_

**d. after finding she could not practice medicine, she re-discovered surface catalysis:**

\_\_\_\_\_

**in who’s laboratory did this rediscovery take place?**

\_\_\_\_\_

**Option 2) Explain Levinthal’s paradox. Use the back of this page if needed.**