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(5 pts)
1) The fastest enzyme, catalase, has a turnover of (i.e. what's the upper limit?)
   a. $4 \times 10^3$ sec$^{-1}$
   b. $4 \times 10^5$ sec$^{-1}$
   c. $4 \times 10^7$ sec$^{-1}$

   Briefly explain turnover (What is it?).

(4 pts)
2) Write the balanced equation for the hydrolysis of ATP. Supply the value for the change in Gibb's Free Energy under standard conditions.

(4 pts)
3) Using the free energy diagram, show how a catalyst affects the change in free energy and the energy of activation. Use S & P as the substrate & product.
4) In 1958, Dan Koshland introduced the idea of the Induced Fit Model regarding enzyme specificity. Briefly explain how this differs from the “Lock & Key” Model.

5) Which of the following is **least** true?
   a. enzymes speed up the forward reaction more than the reverse reaction
   b. enzymes are unchanged by the net reaction
   c. enzymes are required in only trace amounts
   d. enzymes do not alter equilibrium concentrations

6) Classify the following enzyme-catalyzed reactions as to the most appropriate category of the 6 Major Classes (International Commission on Enzymes, 1956).

   ______ Glucose + ATP ⇌ Glucose-6-phosphate + ADP

   A. Hydrolases
   B. Transferases
   C. Ligases
   D. Lyases
   E. Isomerases
   F. Oxidoreductases

   ______ Glucose-6-phosphate + H₂O ⇌ Glucose + P₁
(10 pts)
7) Using the following terms, write the Michaelis-Menten equation. Briefly explain what each term represents. Use 15 words or less per term.

a. M & M equation:

b. $K_M$

c. $V_{max}$

d. [S]

e. v

(3 pts)
8) At a substrate concentration of 1 mM, the rate of the enzyme-catalyzed reaction is $\frac{1}{2}$ of $V_{max}$. At 2 mM substrate concentration,

a. $v = 2V_{max}$

b. $v = V_{max}$

c. $v = \frac{1}{2}V_{max}$

d. none of the above

(6 pts)
9) a. Using the following, illustrate a Lineweaver-Burk double reciprocal plot.
Indicate specifically how the $K_M$ and $V_{max}$ are identified.

b. Illustrate the affect of a noncompetitive inhibitor on this plot.

\[
\frac{1}{V} \\
\frac{1}{[S]} \n\]
(3 pts)
10) Enzyme A & Enzyme B catalyze the same reaction. The $K_M$ for A is $10^{-6}$ M & the $K_M$ for B is $10^{-3}$ M. The $V_{max}$ for both is the same. What statement is most true.
   a. the turnover for A is greater than for B
   b. A has a higher affinity than B for the substrate (A binds stronger/tighter)
   c. if A & B catalyze the same reaction, their $K_M$ & $V_{max}$ values must be the same
   d. none of the above is true

(6 pts)
11) Describe the difference between competitive and noncompetitive inhibitors with regard to:
   a. where they bind the enzyme:

   b. how they affect $K_M$:

   c. how they affect $V_{max}$:

(6 pts)
12) The following 3 conditions were discussed in class regarding enzyme-catalyzed reactions that follow Michaelis-Menten kinetics. Describe what is known about each.
   a. $[S] \gg K_M$

   b. $[S] = K_M$

   c. $[S] \ll K_M$
(12 pts)
13) Illustrate the mechanism used by the serine proteases (as illustrated in class). Use arrows to denote the movement of electrons.
14) Explain (preferably with diagrams) why chymotrypsin, trypsin, and elastase display different specificity for their substrates (i.e. why do they cleave at different sites?).

15) In 1946, Linus Pauling first proposed the idea of transition state analog inhibition. Explain briefly (30 words or less) why these analogs are potent inhibitors.

16) Identify the most true statement:
   a. penicillin is a competitive inhibitor
   b. penicillin inactivates lysozyme irreversibly
   c. penicillin used to be isolated from children’s tears
   d. penicillin is a noncompetitive inhibitor
   e. none of the above is true

17) Identify the least true statement:
   a. when lysozyme catalysis begins, both the active site Asp & Glu must be protonated
   b. lysozyme catalysis generates a positively charged carbonium ion
   c. lysozyme catalyzes hydrolysis of a polysaccharide (polysugar)
(4 pts)
18) Describe zymogens. Use an example to explain their usefulness.

(3 pts)
19) Which of the following is least true?
   a. ribozymes are catalysts composed of RNA
   b. ribozymes display substrate specificity
   c. ribozymes are capable of base-pairing
   d. ribozymes do not follow Michaelis-Menten kinetics

(3 pts)
20) Illustrate (using the graph) the affect of temperature on a typical enzyme-catalyzed reaction.

(2 pts)
21) Define a mechanochemical (chemomechanical) enzyme.
(4 pts)
22) The Cross Bridge Model of Contraction describes the movement of myosin relative to actin. Indicate whether the following is true or false.

_______ in rigor binding, no nucleotide is bound to myosin
_______ binding of ATP causes myosin to release actin
_______ hydrolysis of ATP generates the power stroke before ADP or Pᵢ are released
_______ release of Pᵢ results in strong binding between myosin & actin
(4 pt) Bonus Question
You identify an activator of an enzyme catalyzed reaction. After careful study you find that it affects the $K_m$ but not the $V_{max}$. Draw Michaelis-Menten curves and double reciprocal plots in the presence and absence of this activator. Label the curves.