Exam2key

Wednesday, November 02, 2016 9:44 AM

Name

This exam is schedule for 75 minutes and I anticipate it to take the full time allotted. You are free to leave if you finish.

Multiple Choice

1. Which is not a class of enzyme?

Transferase   Fumarase   Lyase   Oxidoreductase   Isomerase

2. Which of these is commonly involved in redox reactions in biological reactions?

PLP   Catalytic Triad   NADH Mg^{2+}

3. Which of these residues is typically not involved in general acid-base catalysis?

Histidine   Aspartic Acid   Lysine   Asparagine   Arginine   None of the above

4. Formation of a Schiff Base is common with which cofactor?

PLP   NADH   NADPH $FADH_2$ Heme

5. Which of the following is not an example of a secondary messenger?

PCK   IP3   cAMP Ca^{2+}

6. Which type of G protein will inhibit adenylate cyclase?

Ras $G\alpha q$ $G\alpha s$ $G\alpha i$ InhibiG2

7. Which of the following recognizes phosphorylated tyrosine residues in RTK signaling?

G proteins   SH2 domains   SH3 domains   IRS1   Ras

8. Based on the model we discussed for enzyme kinetics, which constant refers to the rate limiting step?

K_M k_1 k_{-1} k_2 k_{-2}

9. Lysozyme uses a covalent intermediate to catalyze a hydrolysis reaction that retains the stereochemistry on the anomeric carbon.

True   False

10. What amino acid forms a covalent bond with the substrate in serine proteases?

Histidine   Aspartic Acid   Lysine   Asparagine   Arginine   None of the above

11. Allosteric molecules interact with the active site of an enzyme

True   False

12. Which corresponds to conformation of hemoglobin that binds O_2 with high affinity?

R-State   S-State   T-State   U-State   Allstate

13. Which of the following increases the affinity of hemoglobin for O_2? Choose all that apply.

CO_2 Basic pH   2,3-BPG   Acidic pH   CO

14. Which type of membrane transport has a linear relationship between flux and [X]?

Passive   Active   Uniport   Antiport   Synport   Non-mediated

15. Which of the following would contribute to a favorable membrane transport ΔG for chloride?

$[Cl^-]_{in} > [Cl^-]_{out}$ $\Delta\Psi = -17$ mV $\Delta\Psi = 170$ mV $[Cl^-]_{in} < [Cl^-]_{out}$

Simple Calculations

16. Given the following data, please calculate k_{cat} and catalytic efficiency. **You must include units.**

$K_M = 1\ \mu M$ $V_{max} = 10\ \mu M\ s^{-1}$ $[E]_{total} = 0.1\ \mu M$

k_{cat} $\underline{100\ s^{-1}}$

Catalytic Efficiency $\underline{100\ \mu M^{-1} s^{-1}}$

$$k_{cat} = \frac{V_{max}}{E_{tot}} = \frac{10\ \mu M\ s^{-1}}{0.1\ \mu M} = 100\ s^{-1}$$

$$Eff = \frac{k_{cat}}{K_M} = \frac{100\ s^{-1}}{1\ \mu M}$$

17. Under these conditions, is Na^+ transport **out of** the cell favorable?

$\Delta\Psi = 55$ mV $[Na+]_{in} = 20$ mM $[Na+]_{out} = 200$ mM

NO

$$\Delta G = RT \ln \frac{[in]}{[out]} + ZF\Delta\Psi$$

$$\Delta G = 8.314(310.15K) \ln \frac{20}{200} + (1)(96485)(0.055V)$$

$$\Delta G = -630.7\ J/mol$$

Transport $\underline{IN}$ is favorable

18. You have determined the Km and Vmax of an enzyme to be 10 µM and 100 µM/min, respectively. In the presence of 50 mM inhibitor, you measured Km to be 0.909 µM and Vmax as 9.09 µM/min.

a. Is this most likely a competitive or uncompetitive inhibitor?

Km + Vmax both decrease

b. Determine K_I.

$K_M' = \frac{K_M}{\alpha}$ $\quad 0.909 = \frac{10}{\alpha}$ $\quad \alpha = 11.001 = 1 + \frac{[I]}{K_I}$

$10 = \frac{50\,mM}{K_I}$

$K_I = 5\,mM$

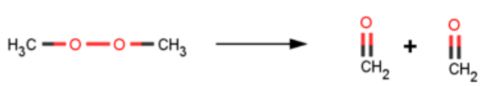
Short Answer

19. For each of the following, determine the class of enzyme that would catalyze the reaction.

Glucose polymerization ligase

lyase

$CH_3Cl + HF \rightleftharpoons CH_3F + HCl$ transferase



oxidoreductase

Lactose + H_2O → glucose + galactose hydrolase

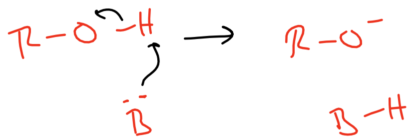
isomerase

20. Myoglobin has a Hill coefficient of 1. What does this mean?

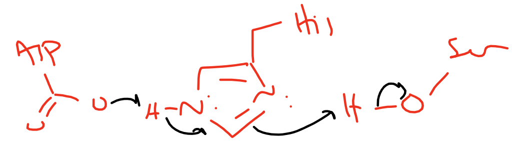
Myoglobin does NOT have any mechanisms for cooperative O_2 binding

21. Consider each of the following reaction mechanism steps. In traditional organic chemistry, each is typically difficult to overcome. Provide at least one example of how an enzyme might make the process easier. Feel free to show a sketch to support your answer.

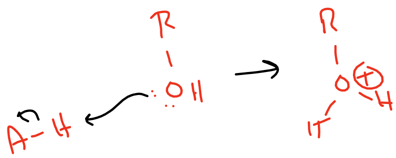
a. A primary alcohol is deprotonated to become a better nucleophile.



serine proteases do this with a catalytic triad



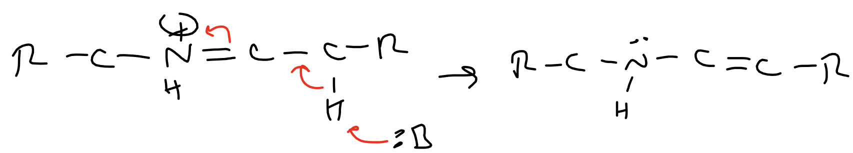
b. Hydroxide needs to become a leaving group.



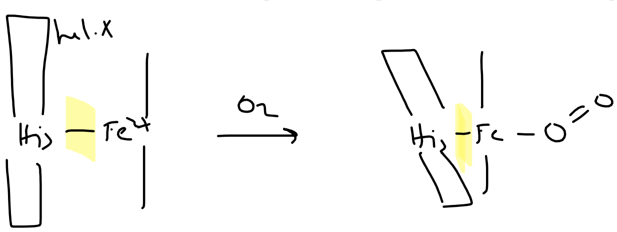
General acid in the active site donates a proton to make H_2O^{+}–R
better L.G.

c. A C-H bond needs to be deprotonated.

We really need an "electron sink" for this. Schiff bases or PLP would be good ideas



22. How does O_2 binding to hemoglobin induce a change from the T state to the R state?



O_2 binding pulls the Fe into the plane of the heme group. It brings the His residue with it & causes a small change in the F-helix. This small change triggers a major change in the structure

23. The activity of nearly all enzymes is pH-sensitive. Please clearly justify this observation.

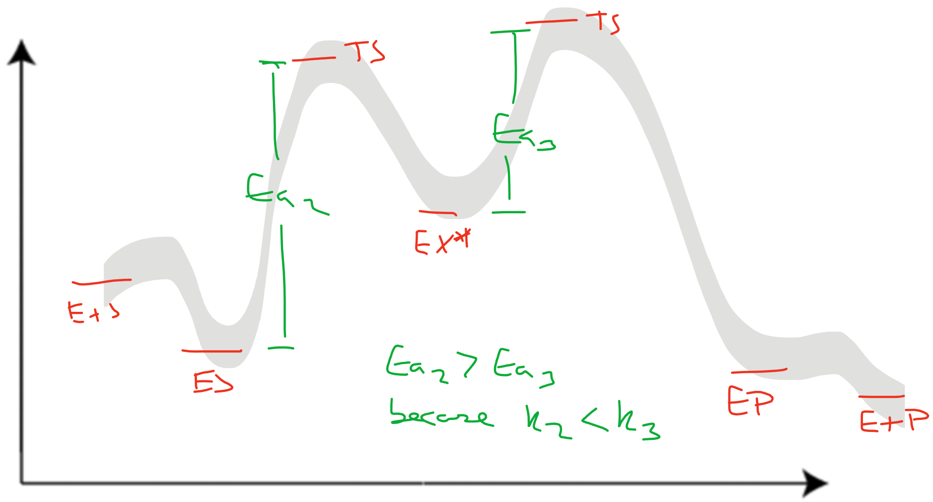
Most enzymes rely on general acid/base catalysis in some way. Changing the pH influences the protonation state of the acid/base residues.

24. Consider the enzyme mediate reaction scheme below. In this mechanism, the enzyme converts the substrate to a temporary product (EX*) prior to making the actual product.

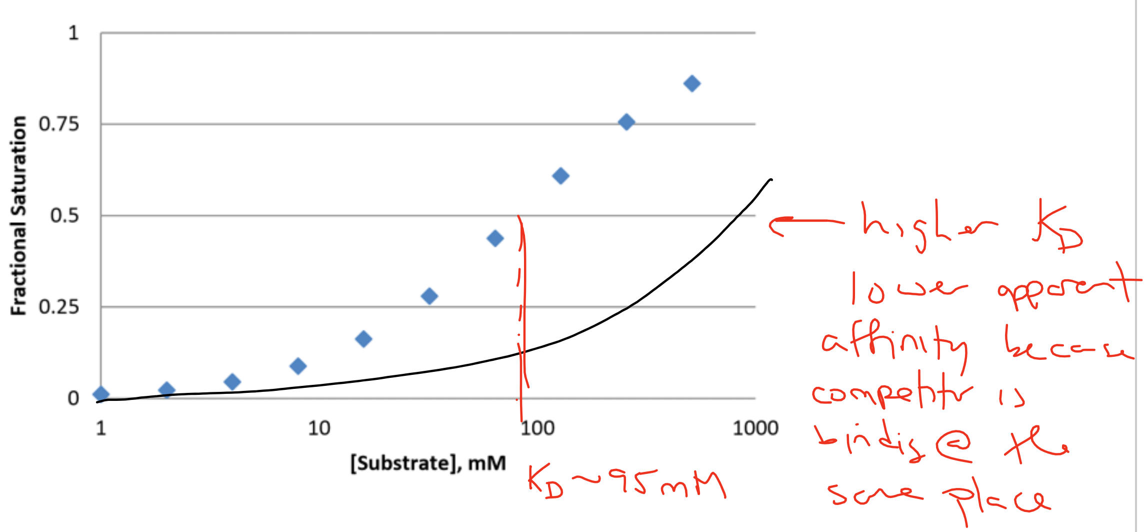
$$E + S \rightleftharpoons ES \xrightarrow{k_2} EX^* \xrightarrow{k_3} EP \rightleftharpoons E + P$$

If $k_2 < k_3$ and all other assumptions of the Michaelis-Menten model hold true:

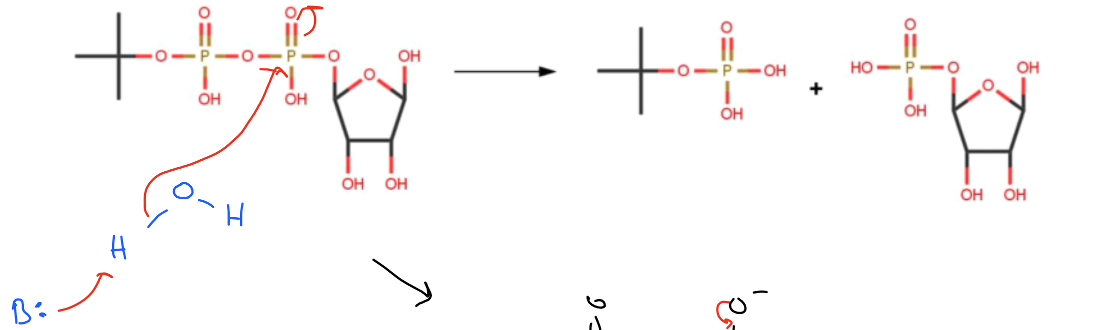
a. What is the rate limiting step? k_2 because k_3 is larger
b. Sketch the reaction coordinate showing the complete conversion of substrate to product.

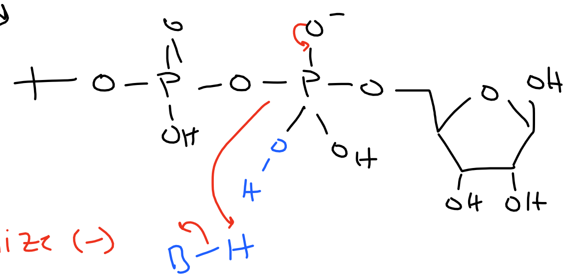


25. Based on the data below:
c. Approximate K_D for the substrate binding to this enzyme.
d. Show how the curve would change if a **competitive inhibitor** were present.



26. Predict a mechanism for the hydrolysis reaction shown below. Make sure to show the transition state. Comment on three ways that the enzyme can stabilize the high energy intermediate.

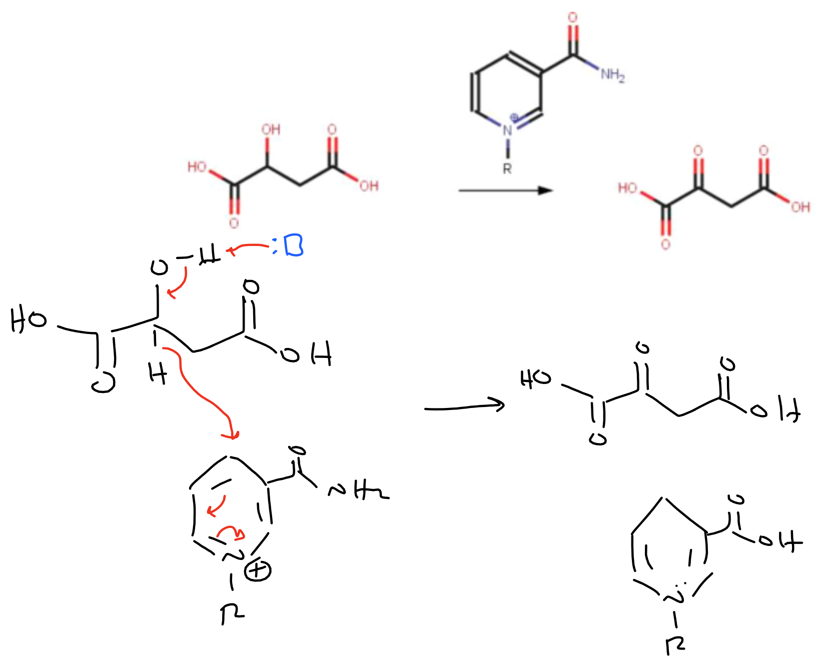




High energy int. has oxyanion

1. Zn^{2+}/Mg^{2+} ion to stabilize (−)
2. Lys/Arg in oxyanion hole
3. H-bond donors in oxyanion hole

27. Propose a mechanism for the NAD^{+}-mediated redox reaction shown below.



Some equations:

$$v = \frac{v_{max}[S]}{K_M[S]} \qquad \propto = 1 + \frac{[I]}{K_I} \qquad \Delta G = RTln\frac{[X]_{in}}{[X]_{out}} + ZF\Delta\Psi$$

Amino Acid	α-carboxylic acid	α-amino	Side chain
Alanine	2.35	9.87	
Arginine	2.01	9.04	12.48
Asparagine	2.02	8.80	
Aspartic Acid	2.10	9.82	3.86
Cysteine	2.05	10.25	8.00
Glutamic Acid	2.10	9.47	4.07
Glutamine	2.17	9.13	
Glycine	2.35	9.78	
Histidine	1.77	9.18	6.10
Isoleucine	2.32	9.76	
Leucine	2.33	9.74	
Lysine	2.18	8.95	10.53
Methionine	2.28	9.21	
Phenylalanine	2.58	9.24	
Proline	2.00	10.60	
Serine	2.21	9.15	
Threonine	2.09	9.10	
Tryptophan	2.38	9.39	
Tyrosine	2.20	9.11	10.07
Valine	2.29	9.72	