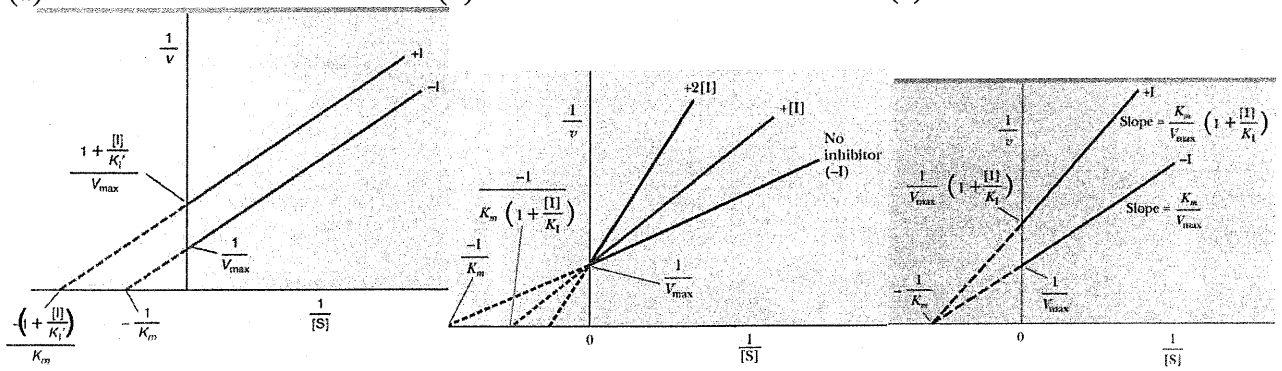
Final Exam

Chap 13-15 (Enzyme kinetics, transition states, regulations) Exam Time: 8-11am 1/10, 2017

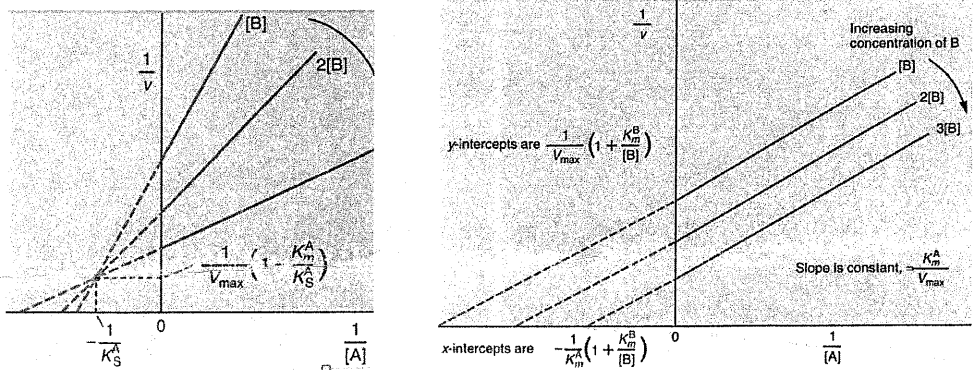
Single Selection (2.5% each)

1. Which one of the following is the mechanism that ATP inhibits glycogen phosphorylase?

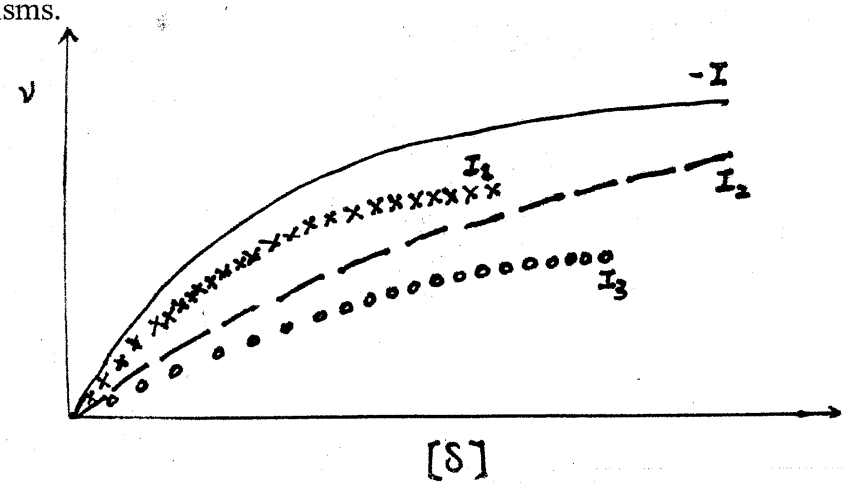
(a) (b) (c)



(d) (e)



2. In the following Michaelis-Menten kinetics for a given enzyme, [-I] means giving no inhibitors to the enzyme while I_1, I_2 and I_3 means the inhibitors that inhibit the enzyme through different binding mechanisms.



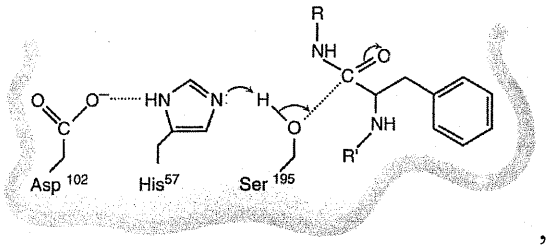
Which of the following is most likely true?

(a) Most of the western medicine is through inhibitory mechanisms such as I_3.
(b) I_1 is noncompatitive inhibition, while I_2 is competitive.
(c) I_3 binds only enzyme-substrate complex
(d) We can obtain the precise V_{max} for [-I] from this chart.

(e) I_2 is the used as if how Viagra inhibits PhosphoDiEsterase 5 (PDE5).

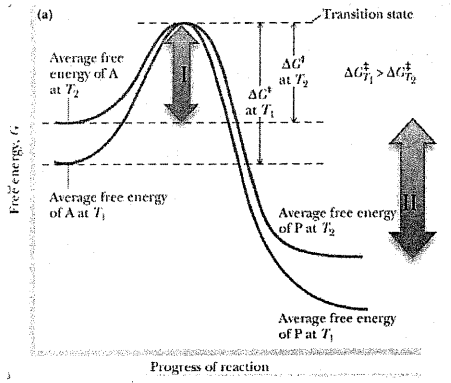
3. Which one of the following is true?
(a) The free energy between Near Attack Conformation (NAC) and the transition state is much narrowed for enzyme-catalyzed reaction than for the non-catalyzed same reaction.
(b) Enzyme is a substrate stabilizer.
(c) Enzyme catalyzes reactions requiring transition state analog.
(d) Enzyme accelerates the chemical reaction by serving as the transition state stabilizer.
(e) Enzyme products will never compete the active site with substrates.

4. For this enzyme reaction



it is a
(a) Single-displacement reaction
(b) Ping-Pong Reaction and C-terminus leaves before the N-terminus of the substrate
(c) Aspartic protease mediated reaction
(d) reaction without water involvement
(e) Trpsin reaction

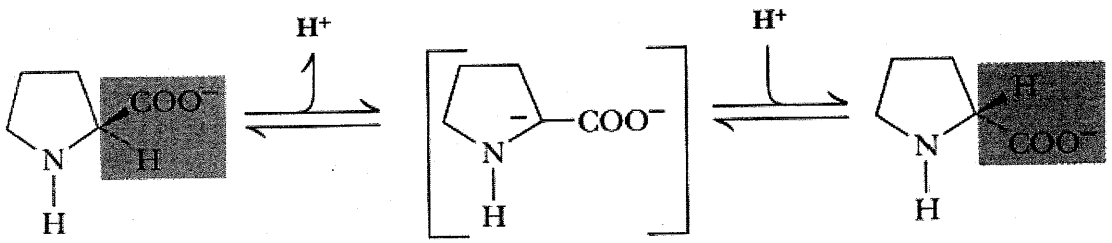
5. Which statement below is inaccurate?



(a) II is thermodynamics property and I is kinetics relevant
(b) Both raising temperature and adding enzyme could lower the kinetic barrier
(c) I is thermodynamics property and II is kinetics relevant
(d) As long as II is large enough, the reaction can be completed at reasonable time frames
(e) The probability for crossing barrier I is proportional to $e^{-\Delta G‡/kT}$

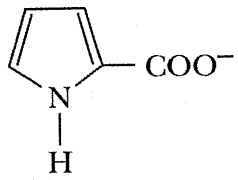
6. Which of the following is incorrect to describe myoglobin (Mb) and hemoglobin (Hb)?
(a) The R-form and T-form of the Hb differ at their salt bridges, H-bonds and covalent linkages between subunits.
(b) Oxygen binding curve of Hb becomes closer to that of Mb in the absence of CO_2 and BPG.
(c) Oxygen binds to a ferrous ion of the heme in both proteins.
(d) At low pH values, the population of R-form is less than the T-from of Hb.
(e) Hb can carry CO_2 but at different site from the one that binds CO and O_2.

7. Which of the following supposedly has the greatest affinity to the proline racemase? (that catalyzes the following reaction)



L-Proline **Planar transition state** **D-Proline**

A transition state analog:



Pyrrole-2-carboxylate

(a) L-Proline
(b) D-Proline
(c) The planar transition state
(d) Pyrrole-2-carboxylate
(e) Proton

8. A plot of 1/v vs. 1/[S] for an enzyme catalyzed reaction gave a line with an equation of $1/v = 0.4/[S] + 0.2$. The same enzyme with an inhibitor present gave a line with an equation of $1/v = 0.4/[S] + 0.8$. Which of the following statements is true?
(a) the type of inhibition is competitive
(b) the type of inhibition is noncompetitive
(c) the type of inhibition is super-competitive
(d) the Km with the inhibitor present has decreased
(e) None of the above

9. We have two enzymes maltose phosphorylase and sucrose phosphorylase catalyzing the following reactions:

Maltose + Pi ⇆ glucose-1-phosphate + glucose (catalyzed by Maltose phosphorylase)
Sucrose + Pi ⇆ glucose-1-phosphate + fructose (catalyzed by Sucrose phosphorylase)

With the presence of unlabeled G-1-P and sucrose phosphorylase in an isotope-labeled $^{32}P_i$ solution, we found the "P" on G-1-P can also be isotope-labeled after some time. However, maltose phosphorylase cannot do the same. Which of following is true:
(a) Sucrose phosphorylase catalyzes a reaction following double-displacement mechanism
(b) Sucrose phosphorylase catalyzes a reaction requiring the formation of tertiary complexes

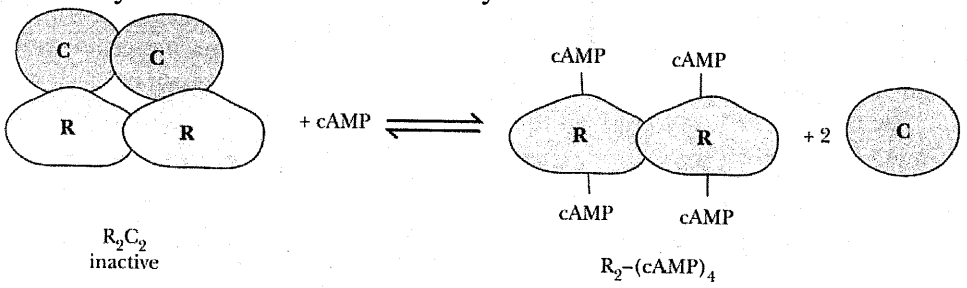
(c) Maltose phosphorylase catalyzes a reaction following what is called "Ping-Pong mechanism"
(d) Maltose phosphorylase catalyzes a reaction where enzyme is covalently modified during the catalysis though the modification occurs only transiently
(e) NAD+-dependent dehydrogenases use a random single-displacement catalytic mechanism

10. About Near Attack Conformation (NAC), which of the following is NOT true?
(a) Computer simulations find that the chance of NAC to form in the enzyme active site can be 300,000 times larger than that of NAC in the absence of the enzyme
(b) the energy difference of E.NAC→E.X^+ is smaller than that of NAC→X^+ where X^+ means the transition state
(c) The enzymatic catalysis benefits from lowering the energy barrier of S→NAC
(d) The transition state analog has a configuration closer to the transition state than the NAC
(e) Both the catalyzed and uncatalyzed reactions require the formation of NAC

11. Which of the following will NOT change the Phosphorylases' activity?
(a) Glucose-6-P
(b) Caffeine
(c) AMP
(d) ADP
(e) ATP

12. About hemoglobin, which of the following is NOT true?
(a) It forms different intra/intermolecular hydrogen-bonding patterns in the 'T' and 'R' forms
(b) It demonstrates a mixed KNF and MWC model
(c) It binds oxygen weaker than myoglobin below the P_{50}.
(d) It is regulated by pH values
(e) It transfers CO_2 to the lung via the oxygen binding pocket.

13. The following figure shows how Cyclic AMP-dependent protein kinase (PKA) is regulated. The catalytic subunits are controlled by:

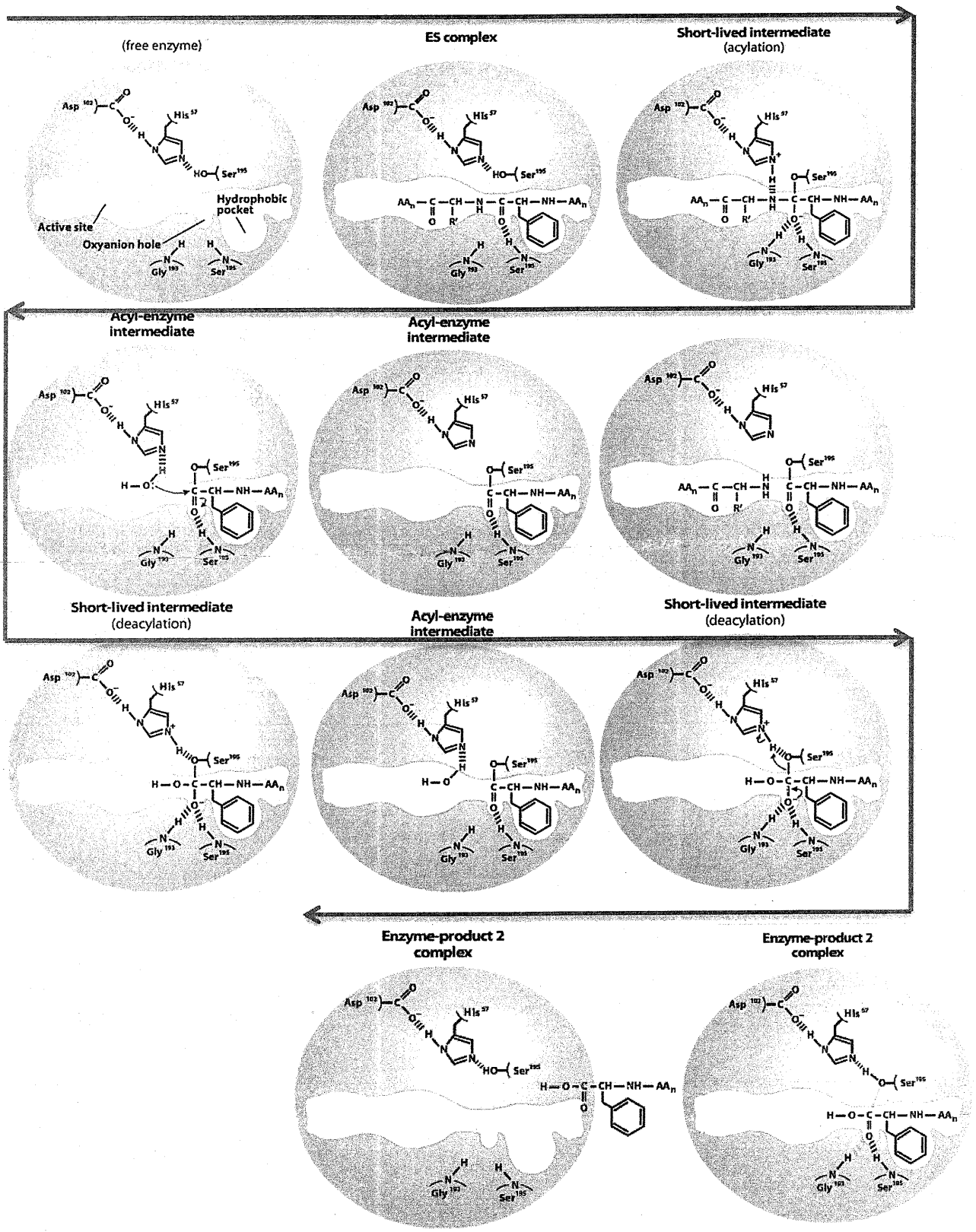


(a) allosteric control
(b) zymogen control
(c) covalent modification
(d) intrasteric control
(e) product inhibition

Q & A

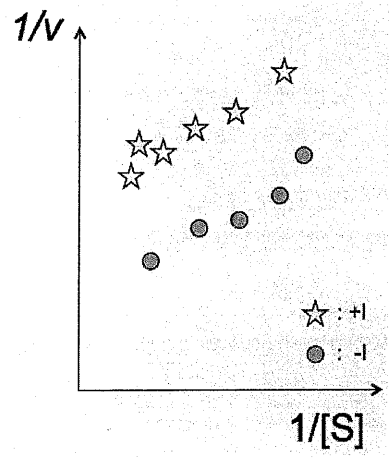
1. Write down the full names, 1- and 3-letter abbreviations, chemical structures and the charge (if applicable) it carries under pH=5.9 for the 20 amino acids. (16%)

2. This is an enzymatic reaction of chymotrypsin. Why does it take phenylalanine as the cleavage point but not other basic residues like what trypsin does? (3%); What does the residue Gly193 do there? (4%) Where exactly do you think the LBHB is being formed? (?row, ?column) (4%); How does it regulate its own activity? (5%)



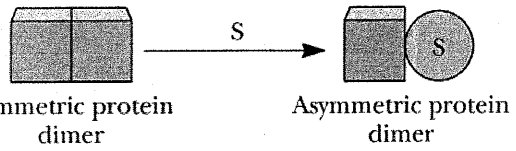
3. Write FOUR approaches how enzymes' activity can be regulated in response to organism's physiological needs and give examples. (10%)

4. The double reciprocal (Lineweaver Burk) plot drawn for an enzyme kinetics study, with or without inhibitor, is shown as below. **(a)** How does inhibitor bind enzyme? (do they compete the same site with the substrate, or substrate and inhibitor bind different sites, or inhibitor binds the enzyme only when substrate binds the enzyme?) (4%) **(b)** which of the following is its "apparent K_m", K_m', under different [I] concentration ? $K_m' = K_m(1+[I]/K_I)$, or $K_m' = K_m$, or $K_m' = K_m /(1+[I]/K_I)$ (3%) **(c)** Please describe how you can do experiments to determine the potency of the inhibitor, K_I (the lower the K_I, the stronger the inhibitor) (3%)

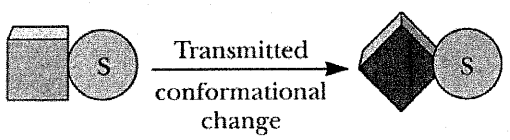


5. What kind of allosteric model is this? (2%); According to the model, is there a ligand-induced conformational change in the enzyme? (3%) Explain how the ligand binding regulates the enzyme activity? Explain how the relative affinity of the three conformers (square, circle and diamond) to the ligand will result in positive and negative cooperativity (6%);

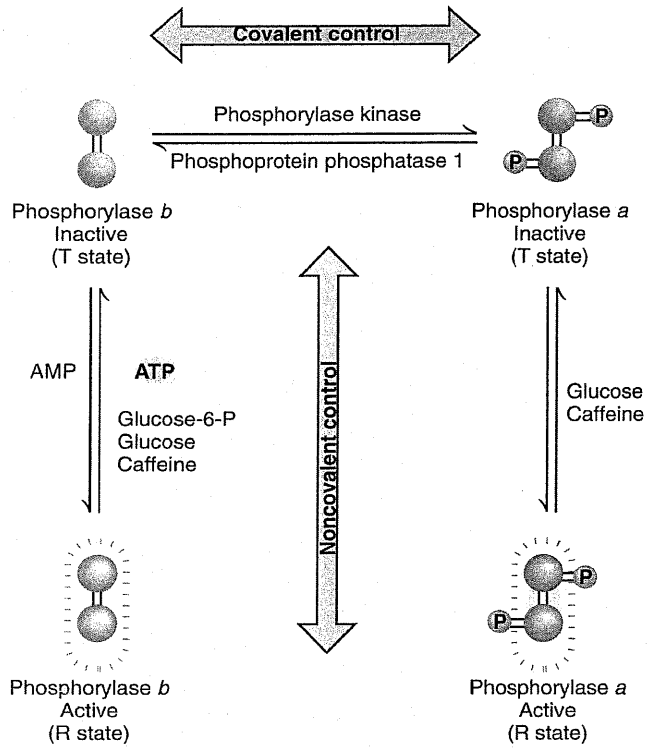
(a) Binding of S induces a conformational change.



(b)



6. In the energy crisis, which form of the four (upper right, upper left, bottom right and bottom left) will assume (2%) and why? (3%) (see next page)


Covalent control
Phosphorylase kinase
Phosphoprotein phosphatase 1
P
P
Phosphorylase b
Inactive
(T state)
Phosphorylase a
Inactive
(T state)
AMP
ATP
Glucose-6-P
Glucose
Caffeine
Noncovalent control
Glucose
Caffeine
P
P
Phosphorylase b
Active
(R state)
Phosphorylase a
Active
(R state)