Exam 4 April 15, 2005 CHEM 3511

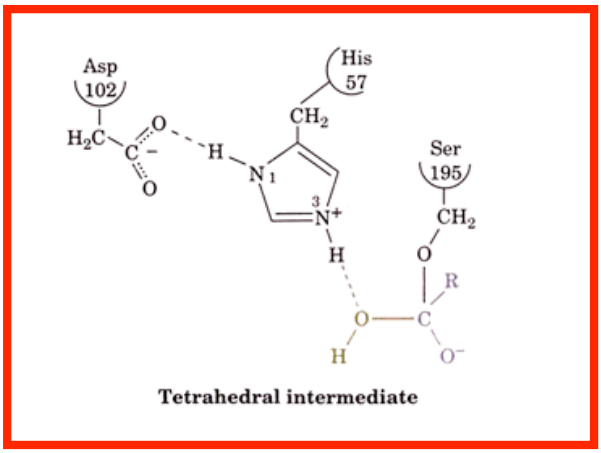
Print Name: KEY Signature _____

1) (8 pts) General Properties of Enzymes. Give four properties of enzymatically-catalyzed reactions. The answers should indicate how enzymatic reactions differ from non-enzymatic reactions. Write four only sentences.

Rates are :
high, accelerated,
under *moderate non-aqueous conditions*, and can be
regulated.
Reactions are *specific* (no side reactions, 100 % yields).

2) (18 pts) Serine Protease Mechanism. The serine protease catalyzed hydrolysis of a peptide bond proceeds via a series of intermediates; (i) a non-covalent enzyme-substrate complex, (ii) a tetrahedral intermediate, (iii) an acyl-enzyme intermediate, (iv) a second acyl-enzyme intermediate, (v) a second tetrahedral intermediate, and (vi) a non-covalent product-enzyme intermediate.

a) (10 pts) Draw the second tetrahedral intermediate, including the catalytic triad. Draw all the hydrogen bonds. In a maximum of two sentences explain how the enzyme stabilizes this intermediate

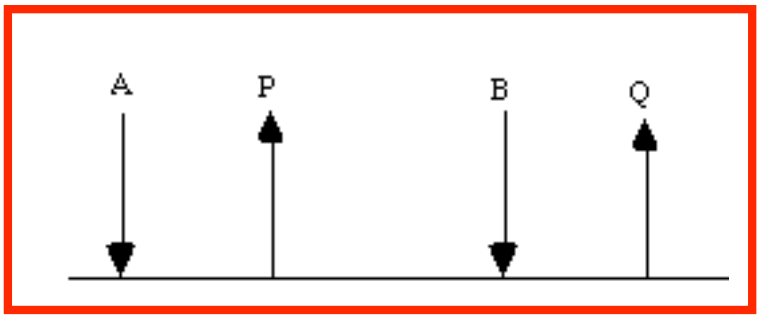


.

The oxyanion (O-minus) is stabilized by hydrogen bonds to two backbone N-H groups (which compose the oxyanion hole).

Print Name: KEY Signature _____

b) (4 pts) Sketch the general mechanism of a bi-bi ping-pong reaction (a ping-pong bisubstrate reaction), using the A, B, P, Q, E, EA-FP, FB-FQ nomenclature described in VV&P. (It is not necessary to labe1 the horizontal axis).



c) (4 pts) A serine protease acts via a bi-bi ping-pong mechanism. State the correspondence between A, B, P, Q and the reactants/products of a serine protease.

A: peptide
B: water
P: peptide fragment 1
Q: peptide fragment 2

Print Name: KEY Signature _____

3) (16 pts total) Enzyme Kinetics. Consider a simple enzymatic reaction:

$$E + S \Longleftrightarrow ES \rightarrow E + P$$

Make the reasonable and usual assumption that the E + S association and dissociation are fast relative to the chemical transformation step (ES -> E + P).

a) (8 pts) State the significance of k_{cat}, K_m and k_{cat}/K_m. and V_{max}, with one sentence or equation for each.

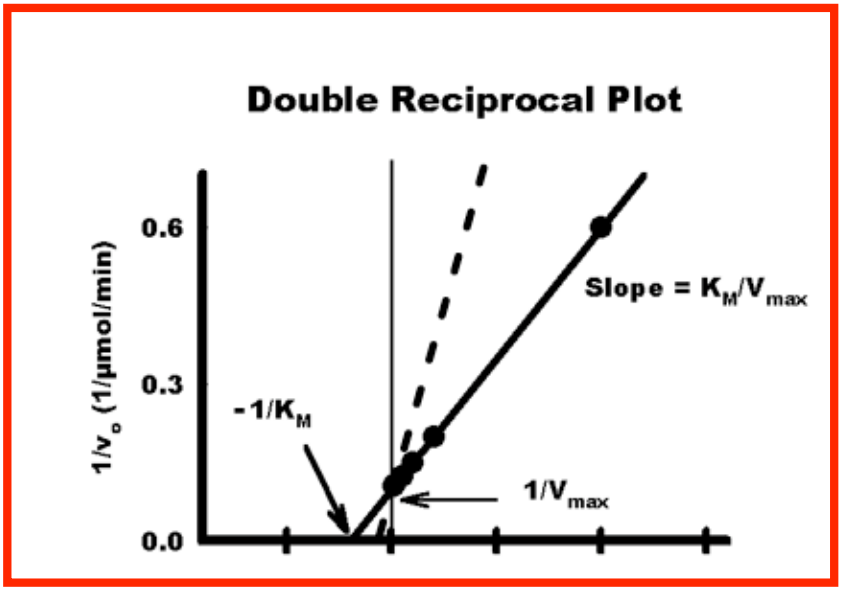
k_{cat} = the rate constant for conversion of ES to E + P, also known as the turnover number.

K_m = the dissociation constant for the enzyme-substrate complex. It is also the substrate concentration when $v=v_{max}/2$

k_{cat}/K_m= pseudo second order rate constant, also known as the catalytic efficiency.

$V_{max} = k_{cat}[E]_{tot}$, which is the maximal velocity of a reaction, observed when the enzyme is saturated.

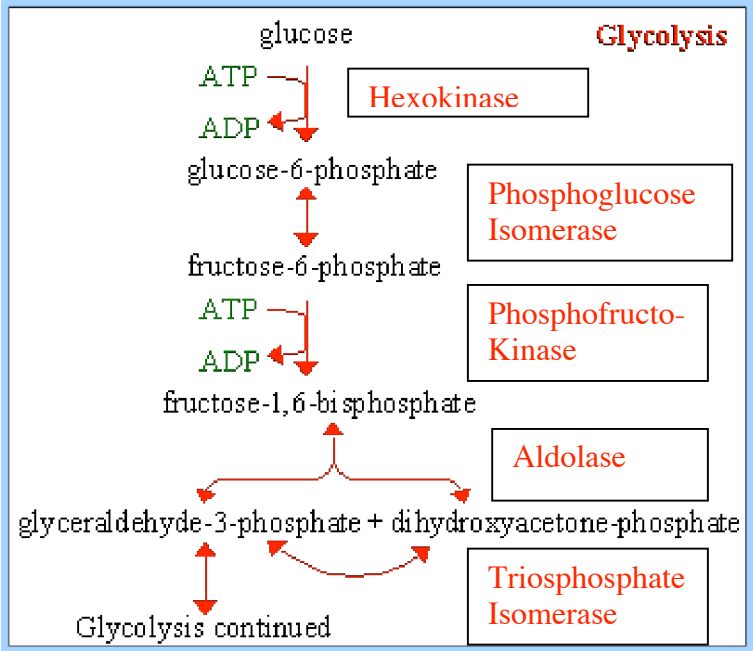
b) (6 pts) Sketch a plot of $\frac{1}{[S]}$ vs $\frac{1}{[v_o]}$. Give the significance of the slope and intercept.



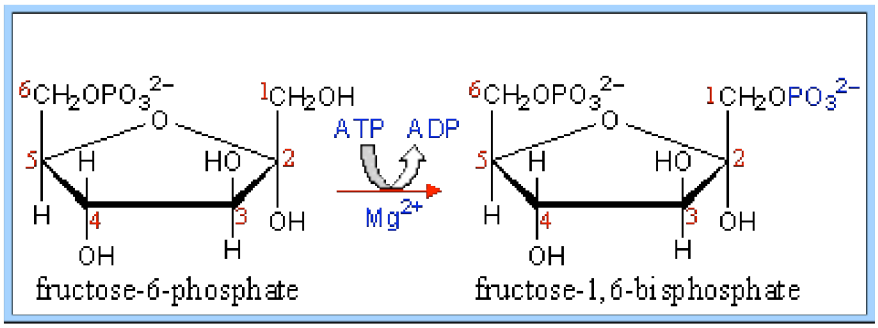
c) (2 pts) With a dashed line, sketch a line anticipated if you added a competitive inhibitor at a single fixed concentration. Add this line to the graph above.

Print Name: KEY Signature _____

4) (12 pts) Glycolysis. Identify the enzymes that catalyze the reactions here:



5) (9 pts total) Glycolysis. For this reaction:



b) (2 pts) Is this reaction regulated? How?

Yes. It is allosterically enhanced by AMP and allosterically inhibited by ATP.

c) (7 pts, fill in the blanks) There are

3

isomerization reactions in glycolysis. The enzymes that catalyze them are

phosphoglucose isomerase, triosphosphate isomerase, phosphoglycerate mutase .

Print Name: KEY Signature _____

6) (14 pts) Citric Acid Cycle.

a) What is the net reaction of the Citric Acid Cycle?

$3NAD^+ + FAD + GDP + Pi + acetyl\text{-}CoA + 2\ H_2O$ ---->

$3NADH + FADH_2 + GTP + CoA + 2CO_2 + 3H^+$

7) True/False (16 pts total, 1 pt each)

a. Proteins are ill-defined and mysterious substances that defy rational analysis.
T or F

b. Kinetic studies can reveal the binding affinity of a substrate for an enzyme.
T or F

c. An enzymatic reaction does not pass through a transition state.
T or F

d. For the unimolecular reaction A -> P, a plot of ln[A] versus time will be linear.
T or F

e. For the biomolecular reaction 2A -> P, a plot of 1/[A] versus time will be linear.
T or F

f. The larger the difference between the free energies of the ground and transition states, the faster a reaction will proceed.
T or F

g. An enzyme can selectively stabilize a transition state.
T or F

h. When a reaction is in "steady state" the difference between the free energies of the reactants and products is zero.
T or F

i. Reaction rates can be enhanced if two reactants are taken out of dilute solution and held in close proximity.
T or F

j. Steady state is equivalent to equilibrium.
T or F

k. An reaction with an unfavorable driving force ($\Delta G>0$) can be driven forward by coupling to a reaction with a favorable driving force ($\Delta G<0$).
T or F

l. Glycolysis converts glucose to pyruvate, without consumption of O_2.
T or F

m. Most of the enzymatic machinery of the Citric Acid Cycle is found in the cytosol.
T or F

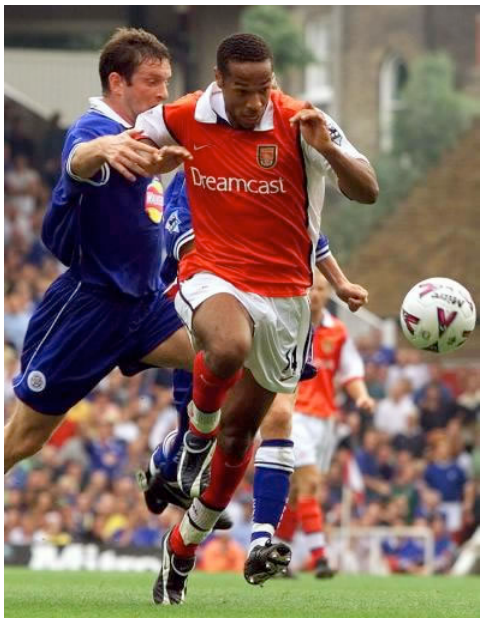
n. The Citric Acid Cycle is a specific pathway for recovery of energy only from carbohydrate.
T or F

Print Name: KEY Signature _____

o. Pyruvate dehydrogenase is regulated by product inhibition (by NADH).
T or F

p. The rate of the reaction catalyzed by phosphofructokinase is sensitive to changes in substrate concentration.
T or F

8. (7 free points) Bonus questions.
a) Who is currently the leading scorer for Arsenal FC?



Thierry Henry

b) Who is the world-wide all-time leading scorer in international soccer?

Mia Hamm