Pink / Yellow

**Section 1: Multiple Choice. 15 questions, 2 points each. Refer to the last page for needed data and equations.**

1. C The α-anomer of glucose and the β-anomer of galactose are different in their stereochemistry at _____ carbon atoms.

A) 0
B) 1
C) 2
D) 3
E) 4

2. D When an allosteric activator is present, the graph of velocity versus substrate concentration will

A) transition from rectangular hyperbolic to sigmoidal
B) reach a lower value of $V_{max}$
C) have a higher value of $K_M$
D) be sigmoidal and shift to the left
E) be rectangular hyperbolic and shift to the right

3. B An uncompetitive inhibitor
A) increases the $V_{max}$ of an enzyme.
B) binds to enzyme only after substrate binds
C) can bind to enzyme before or after substrate binds
D) increases the $K_M$ of an enzyme.
E) forms a covalent bond with the enzyme.

4. C or D The enzyme kinetics parameter $k_{cat}/K_M$ can be useful in all of these situations except which one?

A) comparing the enzyme's preference for different substrates.
B) determining whether the enzyme has reached "catalytic perfection"
C) serving as the second order rate constant when [S] is much greater than $K_M$
D) determining how many substrate molecules can be made into product molecules per unit time when the enzyme is saturated

5. D Chymotrypsin was shown to have a mechanism with two stages

A) Through the use of an affinity label.
B) By a group-specific reagent.
C) With a transition state analog.
D) Because it demonstrates burst kinetics.

6. E Which of the following is not true concerning myoglobin and hemoglobin?

A) Both are "mostly α-helix" proteins.
B) Both have a prosthetically-bound heme group.
C) Both hold their iron atoms in a hydrophobic pocket.
D) Both have distal and proximal histidine residues involved in oxygen binding
E). Both . bind oxygen cooperatively.

7. D 2,3-bisphosphoglycerate is an allosteric regulator

A) That causes the oxygen binding curve of hemoglobin to shift to the left.
B) That allows fetal hemoglobin to bind oxygen with less affinity than maternal hemoglobin.
C) That binds in the central cavity of hemoglobin, shifting the structural equilibrium to the relaxed state.
D) That decreases hemoglobin's affinity for oxygen.
E) That has no significant effect on oxygen binding affinity in hemoglobin.

8. A Penicillin is an example of

A) a mechanism-based inhibitor.
B) a reversible inhibitor.
C) an uncompetitive inhibitor.
D) a transition-state analog.

9. A The most nonpolar of the following lipids is a

A) triacylglyceride.
B) glycolipid.
C) diacylglyderide
D) phosphoglyderide
E) monoacylglyceride.

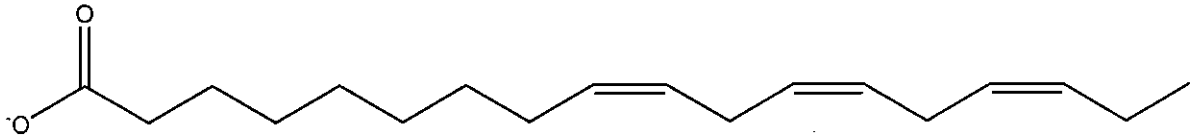
10. C Transport through the $Na^+/K^+$ ATPase is best described as

A) Passive diffusion
B) Facilitated diffusion
C) Active antiport
D) Secondary active symport
E) Symport diffusion

11. D Which is true concerning the potassium ion channel in nerves?

A) It also facilitates chloride ion transport through the membrane.
B) It has an ATP Binding Cassette to allow potassium to travel from high to low gradient.
C) Potassium travels passively through the channel in both directions.
D) Sodium ion is too small to travel through the channel, making it a highly selective channel.
E) Potassium travels through the channel slower than would be predicted because there are 4 sites for potassium ions, which repel each other.

12. B The proper nomenclature to describe the fatty acid below is



A) 16:3 $\Delta^{9,12,15}$
B) 18:3 $\Delta^{9,12,15}$
C) 16:3 $\Delta^{3,6,9}$
D) 18:3 $\Delta^{3,6,9}$

13. D Most digestive proteases are made as zymogens in the _____ for release into the intestine.

A) liver
B) stomach
C) gall bladder
D) pancrease

14. B The action of the potassium/proton pump is essential in digestion primarily to

A) break glycosidic bonds.
B) denature proteins.
C) solubilize lipids.
D) break down glycogen
E) activate lipases.

15. C Which of the following is not a second messenger?

A) cAMP
B) DAG
C) Protein Kinase A
D) $IP_3$

**Section 2: Fill in the blank. 15 questions 2 points each**

16. The two main types of receptors in signal transduction pathways are G-protein coupled receptors and Tyrosine Kinase.

17. The G-protein called Ras is a transducer for epidermal growth factor, and its mutation often leads to cancer.

18. The digestion of ~~carbohydrates~~ polysaccharides start in the mouth by action of the enzyme α-amylase.

19. Lipids is the class of biomolecules that requires additional processing in digestion due to their low water solubility.

20. An enzyme-catalyzed reaction reaches a maximum velocity when substrate concentrations are high because the enzyme is Saturated; there are no enzymes with empty active sites.

21. The Y-intercept of a Lineweaver-Burk plot can be used to determine $V_{max}$ ($K_{cat}$).

22. Competitive inhibition can be overcome by increasing the concentration of substrate.

23. Aspartate, histidine, and serine act as a unit called the catalytic triad to increase the rate of reaction in the enzyme chymotrypsin.

24. Raising the pH of blood would cause a shift in hemoglobin's structure toward the relaxed (tense/relaxed) state, leading to an increase (increase/decrease) in oxygen binding affinity.

25. Sickle cell anemia is the name of a disease caused by a mutation in hemoglobin causing fibers to form, leading to unusually shaped red blood cells.

26. Carbohydrates which differ only by the stereochemistry at one center are called epimers.

27. An example of a ketotriose is dihydroxyacetone or  .

28. Cholesteral is a lipid that strongly impacts membrane fluidity by making it more fluid at low temperature and more solid at high temperature..

29. Photobleaching experiments proved that lateral diffusion of phospholipids is fast in the membrane; transverse diffusion is slow and requires a flippase.

30. Integral proteins are strongly associated with the membrane, usually spanning the lipid bilayer. β-barrel proteins and 7-transmembrane helix receptors are two examples.

W/B/P/Y

**Section 3. Problems.**

12 pts 31. You have isolated two versions of the same enzyme, a wild type and a mutant differing from the wild type at a single amino acid. Working carefully but expeditiously, you then establish the following kinetic characteristics of the enzymes.

| | Maximum velocity | $K_M$ |
|---|---|---|
| Wild Type | 100 μM/min | 10 mM |
| Mutant | 1 μM/min | 0.1 mM |

A. With the assumption that the two-step reaction in which $k_{-1}$ is much larger than $k_2$, which enzyme has the higher affinity for the substrate?

(+2) Mutant

B. With the assumption that the experiments were all run with the same [E], which enzyme has the greater turnover number?

(+2) wild type

C. Which enzyme has a greater catalytic efficiency?

(+2) neither - same in each case

D. Which enzyme alters the equilibrium more in the direction of product?

(+2) neither - enzymes don't alter thermodynamics

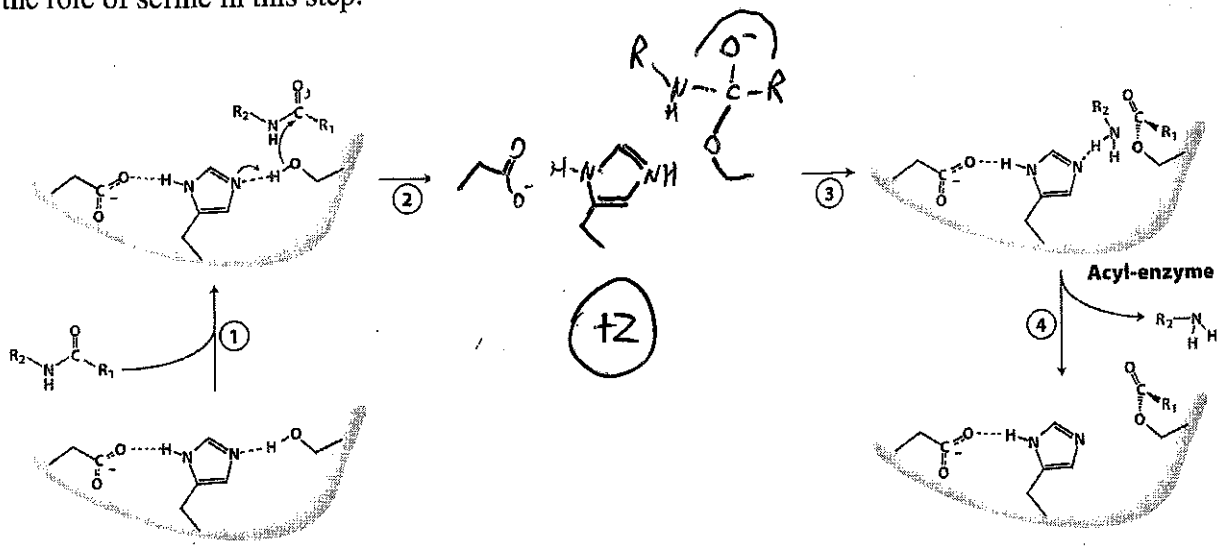
E. What is the initial velocity of the reaction catalyzed by the wild-type enzyme when the substrate concentration is 10 mM? Explain how you came to this value without needing a calculator.

(+2) 50 μM/min. When $[S] = K_m$, $V_0 = \frac{1}{2} V_{max}$.

F. What is the approximate initial velocity of the reaction catalyzed by the mutant enzyme when the substrate concentration is 10 mM? Explain how you came to this value without needing a calculator.

(+2) ~ 1 μM/min. When $[S] \gg K_m$, $V_0 \approx V_{max}$

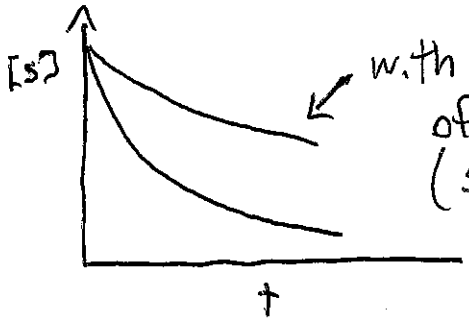
32. A. Below is a partial mechanism for chymotrypsin. Fill in the product of step 2, and explain the role of serine in this step.




+2

+2 serine acts as a covalent catalyst - Nu:⁻ attack on carbonyl of amide

B. For this catalyzed reaction, draw a graph of the concentration of substrate as a function of time. Then redraw the same graph if the enzyme were treated with a transition state analog. Emphasize how the graph has changed.

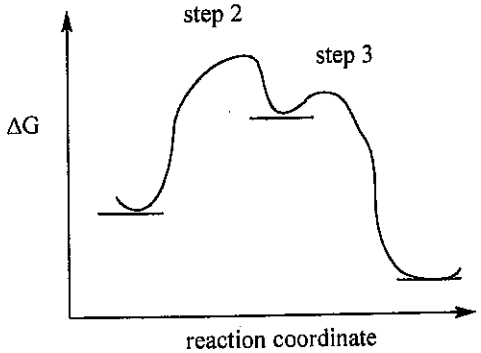


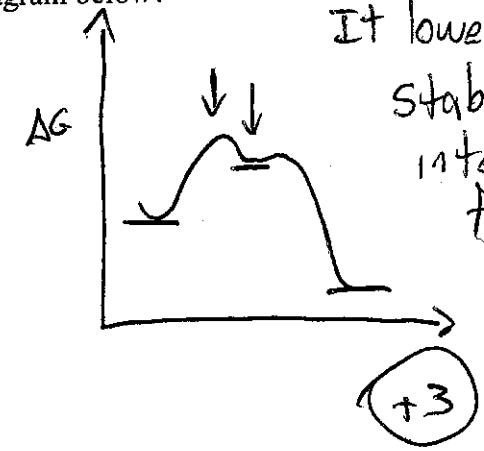

with inhibitor, rate of rxn is slowed (S disappears slower)

+2 shape of curve, graph

+1 change with inhibitor

C. The enzyme speeds up step 2 of this reaction by stabilizing the tetrahedral intermediate. How would the enzyme change the energy diagram below?

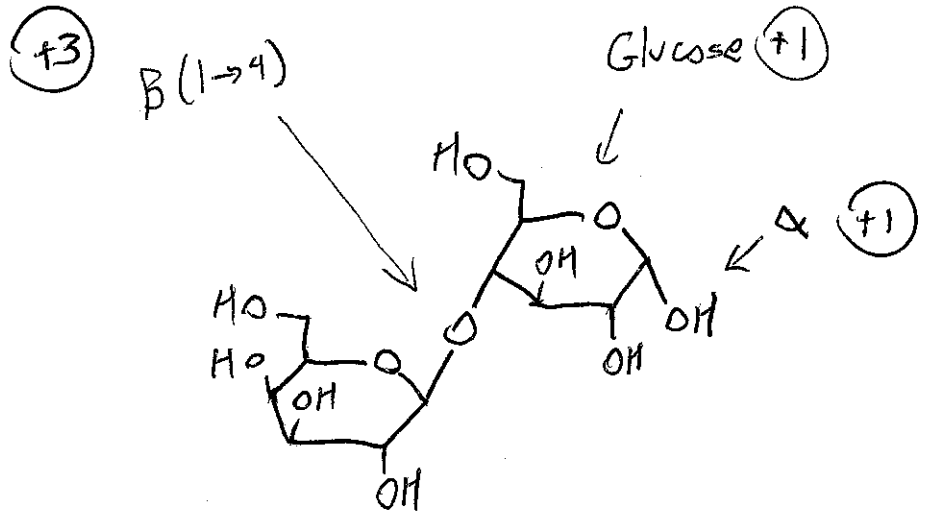



It lowers $E_a$ by stabilizing the intermediate formed in the RDS.

+3

33. Draw the structure of the alpha anomer of the disaccharide lactose below. Lactose is made up of a galactose residue attached to a glucose residue through a beta(1→ 4) linkage. The glucose is on the reducing end of the disaccharide.




5 pts - subtracted for errors in drawing/stereochem

34. Fill in the table below. In the left hand column, fill in the general components of a signal transduction pathway in the right order. Use the terms receptor, second messenger, ligand, target protein, and transducer. In the right hand column, give an example of each from the β-adrenergic receptor.

Order (+4)

| Signal Transduction component | β-adrenergic receptor |
|---|---|
| ligand | epinephrine (adrenaline) |
| receptor | β-adrenergic receptor |
| transducer | G-protein |
| second messenger | cAMP |
| target protein | PKA, glycogen phosphorylase |

examples (+4)

A mutated form of the α-subunit of heterotrimeric G protein has been identified; this form readily exchanges GDP for GTP even in the absence of an activated receptor. What would the effect be on a signaling pathway containing mutated G- protein?

(+3) constitutively active

Glucose is mobilized for ATP generation in muscle in response to epinephrine. How would inhibitors of cAMP phosphodiesterase affect glucose mobilization in muscle?

(+3) [cAMP] remain high even with no epinephrine, leading to constant glucose metabolism

**Bonus:** Lineweaver-Burk plots were determined for an enzyme catalyzed reaction. Three trials were performed, with the only difference being a change in enzyme concentration in each trial. Draw the lines for the three trials on the graph below. Be sure to label your axes.