BIOS 452/CHEM 452

Third Exam

Fall, 2010

12:00-12:55pm, Monday, November 22, 2010

Name: Answer Key

UIN: _____

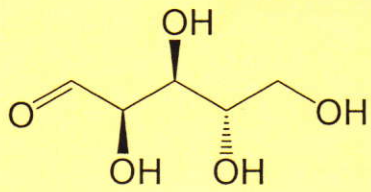
Circle Discussion Section:

Mon	8
Tue	9:30
Wed	9
Thu	9:30
Fri	9
Fri	11

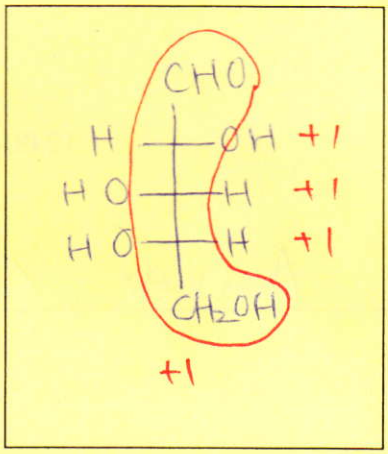
General Instruction

* Do not turn the page until you are told to do so.
* You may take the exam with you only after 12:35pm.
* No calculators allowed. **For calculations and graphing, show all your work!!!**
* The exam is total 9 pages (including cover page), ~30 questions grouped into 15 for 55 minutes.
* Read the question carefully to the end.
* Pay attention to units.

1. (4 pts) Draw the Fisher projection of the sugar shown below.



Fisher →



2. (1-3) Choose from following:

(a) Glucose	(b) Galactose	(c) Ribose	(d) Sucrose	(e) Fructose

(1) (2 pts) Which one is enriched in nerve tissues and thus called "brain sugar"? (b)

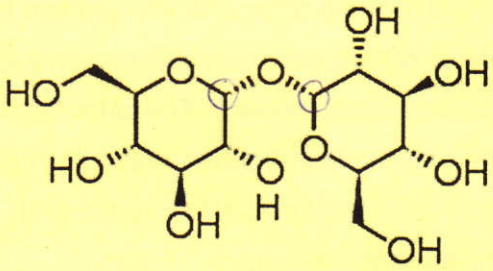
(2) (2 pts) Which has the highest molecular weight? (d)

(3) (2 pts) Which ones are diastereomers of one another? Choose all that apply. (a) x (b)

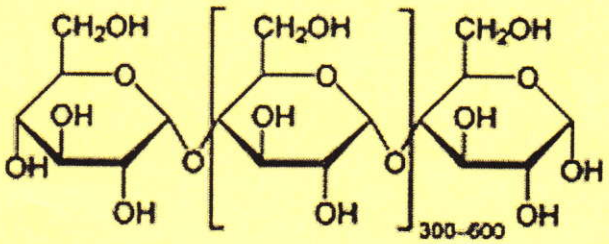
3. Shown on the right is a disaccharide called Trehalose. +3 for both +1 for one

(1) (3 pts) Circle all the anomeric carbons.

(2) (3 pts) Trehalose as shown on the right is an (acetal, ketal, hemiacetal, hemiketal –*Circle one*)



4. (5 pts) Shown on the right is Amylose. The repeating DISACCHARIDE unit of this sugar is Maltose +2, which has (X +1; *Choose either α or β*) anomers linked via (1 +1 -->



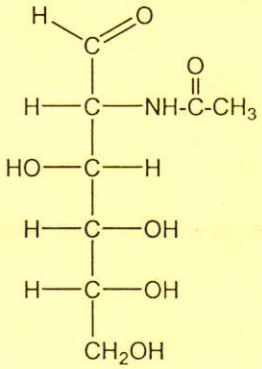
4 +1
_____; *Write in numbers*) glycosidic bond.

**Make sure you filled out ALL of the 4 BLANKS.*

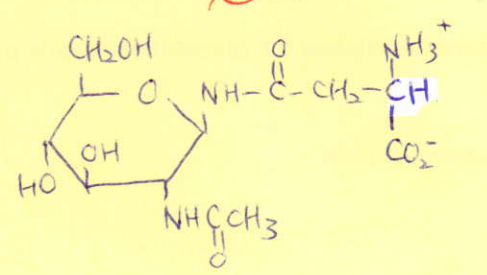
5. (1) (2 pts) Write the name of an amino acid that can form N-linked glycosidic bonds with carbohydrates.

asparagine - *Choose from the 20 amino acids.*
Asn or N

(2) (6 pts) Show the structure of the amino acid you chose (in 1) covalently attached to the monosaccharide on the right in its β-conformation, as it may appear in a glycoprotein.

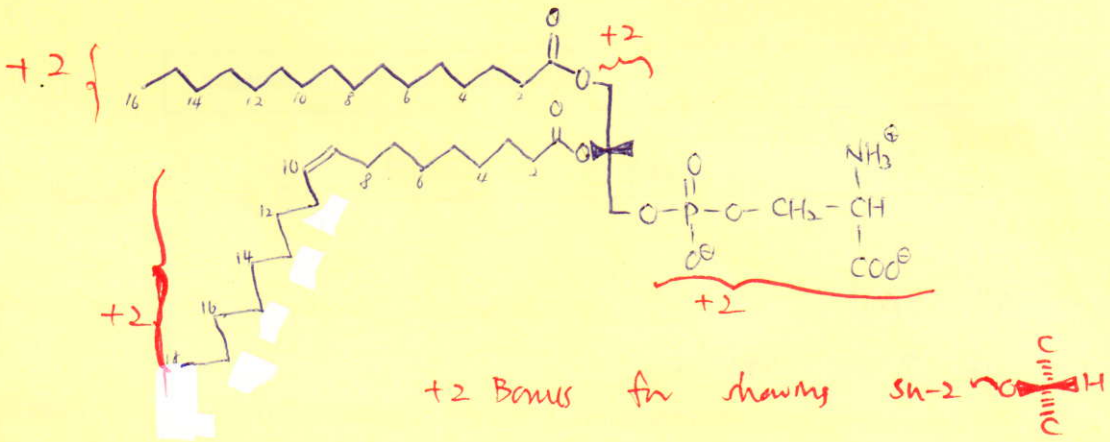


+2 +2



+2

6. (1) (8 pts + 2 Bonus pts with correct stereochemistry.) Mild hydrolysis of a naturally occurring lipid with dilute NaOH generated **L**-glycerol 3-phosphoserine and the sodium salts of a hexadecanoate and a Δ^9-octadecenoate. Draw a chemical structure of the parent lipid.



(2) (4 pts) What are the common names of the constituent fatty acids indicated in (1)?

Palmitate AND Oleate
or or
Palmitic acid Oleic acid
-1 for each typo

(3) (3 pts) What is the net charge of the parent lipid in (a) at a neutral pH?

(Positive, (Negative) Neutral –*Circle one*)

7. (3 pts) Which of the following INCREASE(S) during the hydrogenation process used in making traditional margarine? *Circle all that apply.*

(a) Number of saturated bonds (b) Trans-fat content (c) Food calories per molecule (d) Melting point of the fat

+3 for all 4
+2 for 3
+1 for 2

8. (3 pts) Indicate TRUE (T) or FALSE (F) for each of the following statements about the plasma membrane of a cell.

+1 **(1)** The lateral diffusion of molecules is much easier than the transverse diffusion. T

+1 **(2)** Free fatty acids are a major component. F

+1 **(3)** Glycoproteins and glycolipids expose their carbohydrate groups on the outer leaflet of the bilayer. T

9. (3 pts) Arrange the following compounds (a)-(e) in an increasing order of permeability across a pure synthetic lipid bilayer.

(a) Cl^-	(b) O_2	(c) Water	(d) Glycerol	(e) Glucose

(a) < (e) < (d) < (c) < (b)

+3 → all correct
+1 → if 3 are correct.

10. (3 pts) A spontaneous conversion of a compound S to another compound P has a forward reaction rate constant, k_f of 100 hour^{-1} and a reverse reaction rate contstant, k_r of 1 hour^{-1}. In an enzyme-catalyzed reaction, the same conversion takes place with a different k_f ($k_{f,\ catalyzed}$) that is 2 sec^{-1}, what would be the $k_{r,\ catalyzed}$ of this reaction? *Make sure to write a unit to your answer.*

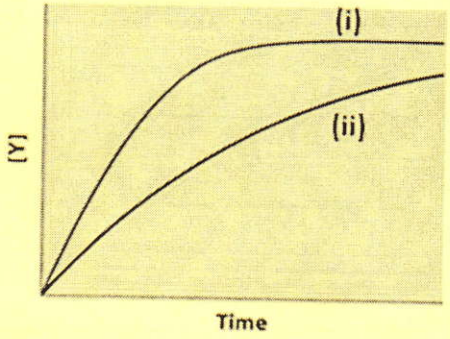
$$S \underset{k_r}{\overset{k_f}{\rightleftharpoons}} P$$

$$\frac{k_f}{k_r} = \frac{100\ h^{-1}}{1\ h^{-1}} = \frac{k_{f,\ catalyzed}}{k_{r,\ catalyzed}} = \frac{2\ sec^{-1}}{?}$$

+2 for correct formula

$k_{r,\ catalyzed}$? = 0.02 sec

11. (6 pts) An enzyme (E) catalyzes the conversion of substrate X to product Y. The plot on the right shows the concentrations of Y ([Y]) versus time of reactions. Can the following change in the reaction condition shift the curve from (i) to (ii)? Answer Yes(Y) or No(N).



+2 **(1)** Add an uncompetitive inhibitor. Y

+2 **(2)** Replace the substrate X with X' that has a lower K_m but the same $V_{max.}$ N

+2 **(3)** Decrease the total reaction volume without changing the concentrations of reaction components. N

12. Below is a kinetic scheme of a simple enzyme-catalyzed reaction.

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_2} E + P$$

Michaelis & Menten used a steady state assumption to express the reaction velocity ($= \frac{d[P]}{dt}$) as a function of quantities that can be easily measured such as $[E]_{total}$ and $[S]_{total}$: $\mathbf{V=k_2*[E]_{total}*[S]/(K_m+[S])}$ *(eq. 1)*

(1) (4 pts) Write a rate equation, i.e., a differential equation, that describes the steady state assumption.

should show both:

+2 $\frac{d[ES]}{dt} = k_1[E][S] - k_{-1}[ES] - k_2[ES]$

* just saying $k_1[E][S] = k_{-1}[ES] + k_2[ES]$ is +2.

$\Leftrightarrow$

+2 $\frac{d[ES]}{dt} = 0$ or $[ES] = \text{constant}$

(2) (3 pts) In the *eq. 1,* [S]is the concentration of free S, NOT total S ($[S]_{total}$). Nevertheless, we often take the value of [S] as that of $[S]_{total}$. Why?

$\because [S]_{total} >> [E]_{total}$

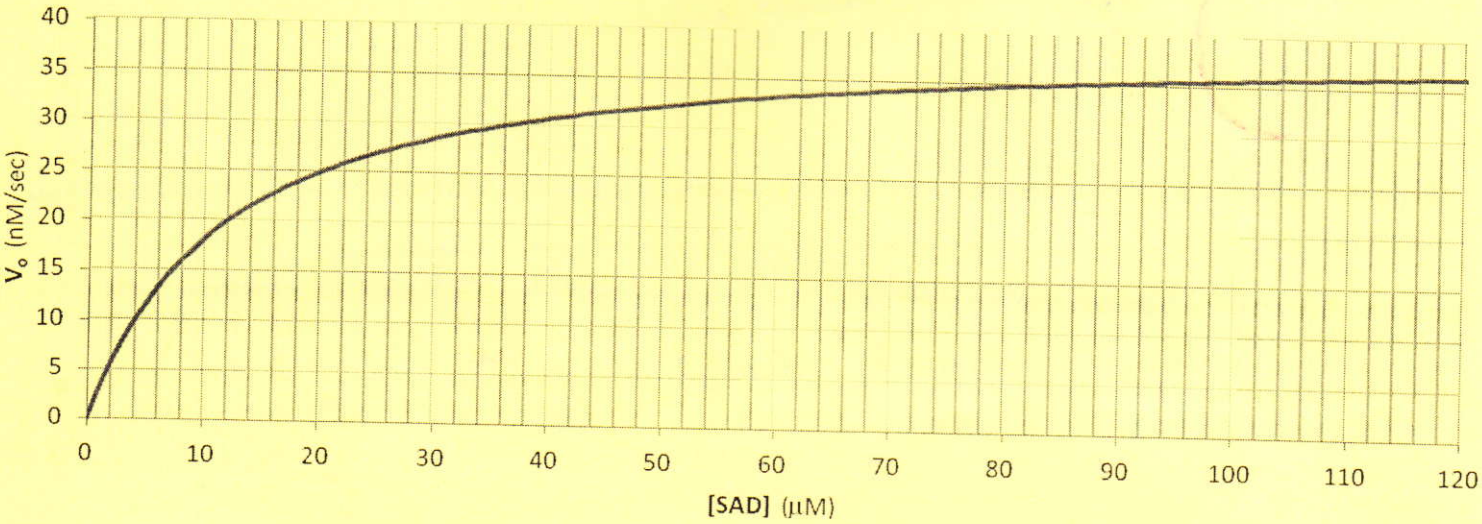
(3) (3 pts) Which describes the condition under which K_m can be regarded as the dissociation constant of the binding equilibrium between E and S to form ES complex?

($k_1 >> k_{-1}$, $k_1 >> k_2$, **($k_{-1} >> k_2$)**

$k_1 << k_{-1}$, $k_1 << k_2$, $k_{-1} << k_2$ - *Circle one.*)

13. An enzyme called "happyase" catalyzes the following reaction with a k_{cat} of 100 sec^{-1}: SAD $\rightleftharpoons$ HAPPY

Below is a plot of the initial velocity versus the substrate concentration for happyase. The initial velocity at 1 mM [SAD] was measured to be 40 nM/sec.



(1) (3 pts) What is the total happyase concentration used above? Indicate unit.

$$[E]_T = \frac{V_{max}}{k_{cat}} = \frac{40\,nM\,sec^{-1}}{100\,sec^{-1}} = 0.4\,nM$$

−1 for using V_{max} 35 − 39 nM/sec

(2) (4 pts) What is the K_m of happyase for SAD? Indicate unit.

12 μM

+2 for showing $K_m = [S]$ when $V_o = \frac{V_{max}}{2}$ on graph (or calculations?)
e.g 10μM w/ showing has it done.

(3) (4 pts) What is the SAD concentration at time = 0 when 480 pmole of HAPPPY is formed during the first minute in a 1-ml reaction?

+2 $\left\{ V_o = \frac{480\,pmole}{1\,ml} \cdot \frac{1}{60\,sec} = 8\,nM/sec \right\} = \frac{40\,nM/sec \cdot [S]}{12\,\mu M + [S]}$

$$8(12 + [S]) = 40[S]$$

$$\therefore [S] = \frac{12}{4}\,\mu M = 3\,\mu M$$

• If formula or then +3.

(4) (3 pts) Considering the diffusion-limited bimolecular rate constant is $1 \times 10^8\ M^{-1} s^{-1}$, how much slower is the reaction catalyzed by happyase than a diffusion-limited reaction? (1, (10,) 100, 1000, 10,000 – *Circle one*) – times.

+2

$\frac{k_{cat}}{K_M} = \frac{100\ sec^{-1}}{1\ \mu M} \sim 10^7\ M^{-1} sec^{-1}$

(5) (Bonus 3 pts) In a separate experiment, the total enzyme concentration was decreased by 2-fold. How does the V_{max} and K_m change?

V_{max} decreases by 2-fold +1

K_M doesn't change +1

(6) (Bonus 2 pts) Thus the effect of reducing total enzyme concentration is similar to the effect of adding a (Competitive, Uncompetitive, (Noncompetitive – *Circle one*) inhibitor.

14. (1) (3 pts) STRESS is a competitive inhibitor of happyase described in ~~16~~ 13. Draw a kinetic scheme for competitive inhibition.

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

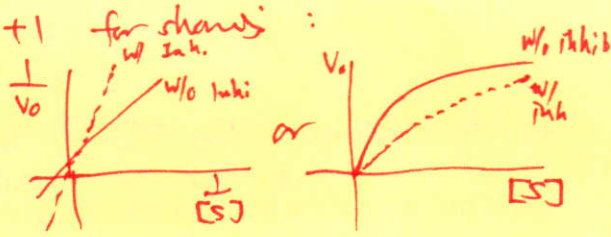
$+$

I

$\Updownarrow$

EI

+1 for shape:



(2) (4 pts) Ki of STRESS is 10 nM. Calculate the apparent K_m and the apparent k_{cat} when 10 nM STRESS is added to a happyase-catalyzed reaction which shows K_m of 9 uM and k_{cat} of 120 sec^{-1} in the absence of any inhibitor.

+1

$\alpha = 1 + \frac{10\ nM}{10\ nM} = 2$

Competitive $\therefore \rightarrow K_{m,app} = \alpha \cdot K_m = 2 \times 9\ \mu M = 18\ \mu M$

$V_{max,app} = V_{max}$

Thus

$\rightarrow k_{cat,app} = k_{cat} = 120\ sec^{-1}$

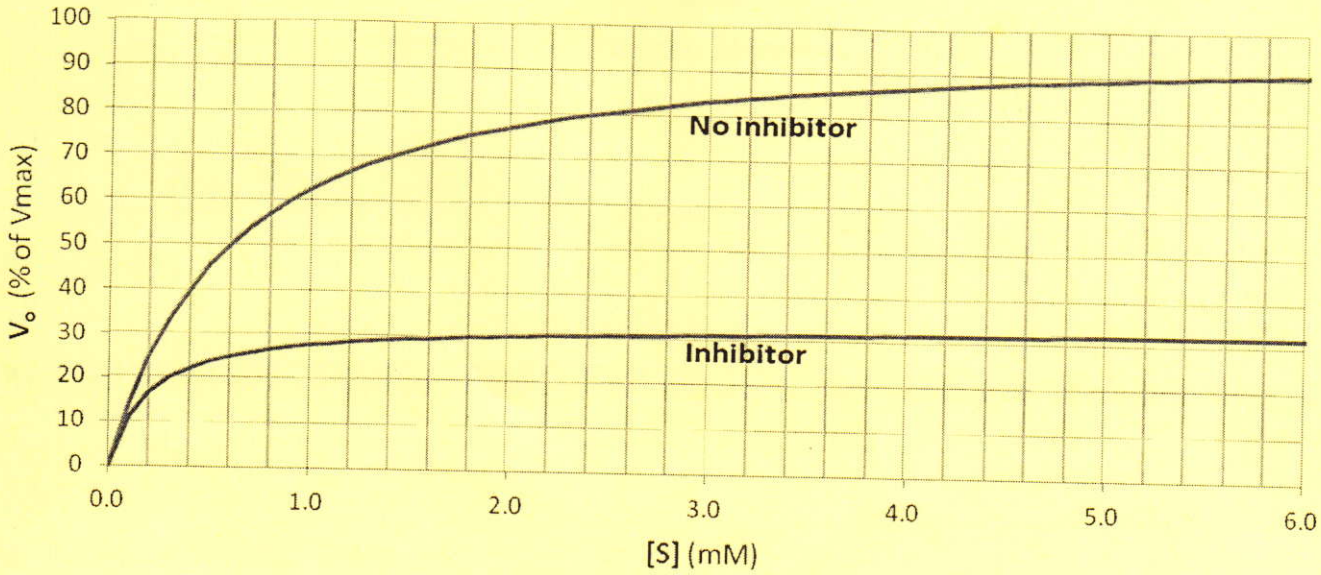
+1 α

+1 K_m

+1 k_{cat}

+1 for numeric calculation itself

15. The experimental curve of initial reaction velocity versus [S] with and without inhibitor (I) is shown for an enzyme and a substrate.

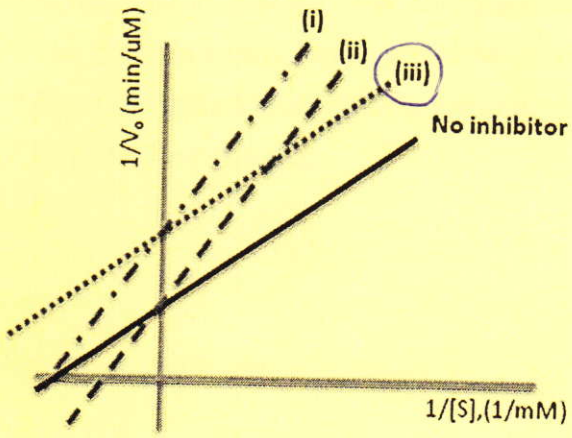


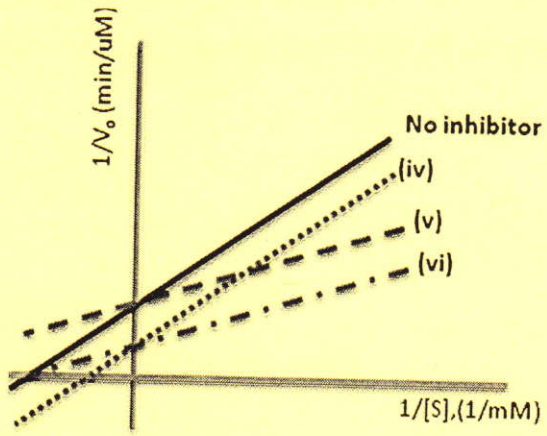
(1) (4 pts) What is a possible mechanism of inhibition?

(Competitive, Uncompetitive, Noncompetitive - *Circle one.*)

+2 for showing correct $V_{m,app} = \frac{V_m}{\alpha'}$ & $K_{m,app} = \frac{K_m}{\alpha'}$ where $\alpha = 3$.

(2) (3 pts) Which best describes the Lineweaver-Burke plot of the enzyme with the inhibitor (I) at [I]=Ki. Circle one among (i) to (vi)





+1 for matching graph w/ (I)