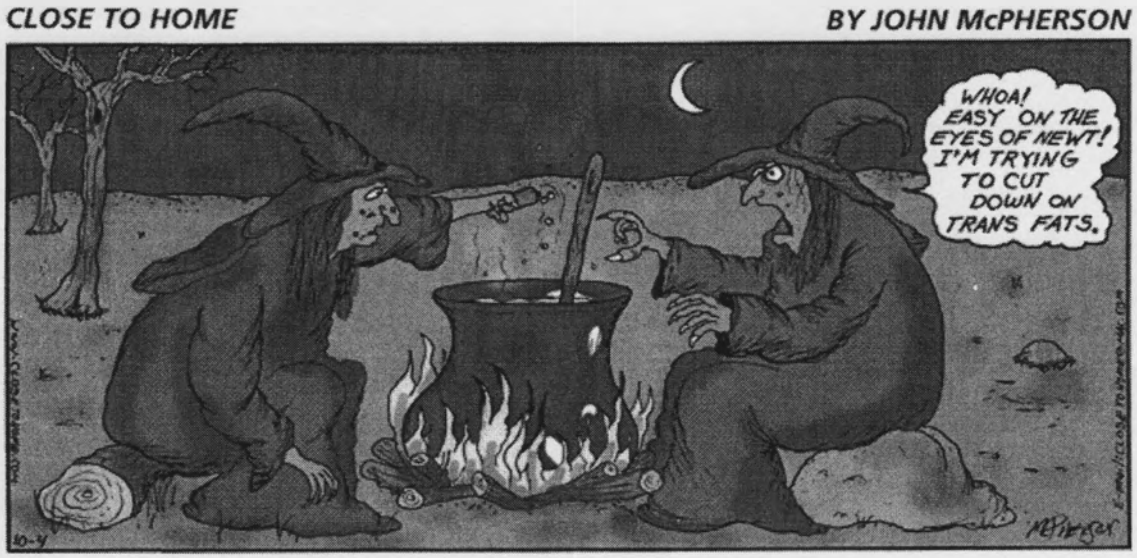
Chemistry 333
Principles of Biochemistry
Fall 2009
Second Exam
October 29, 2009

NAME: KEY



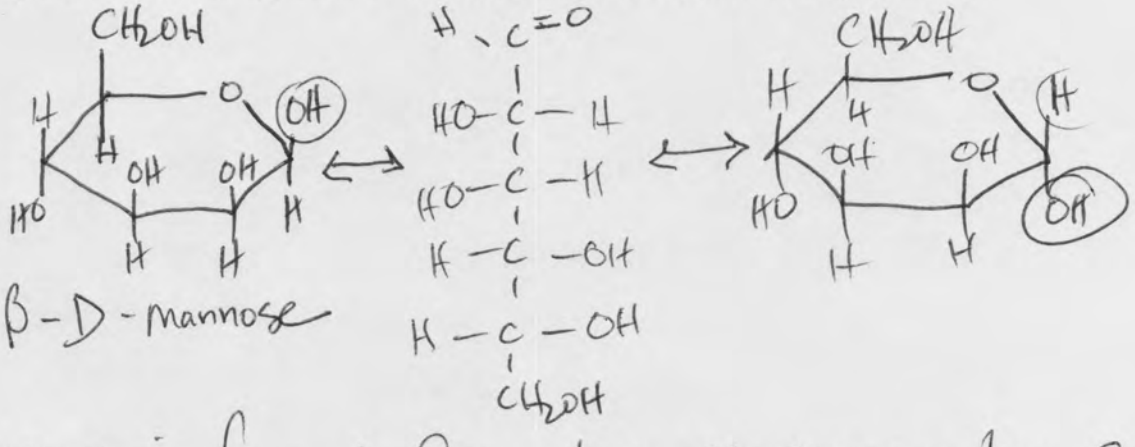
1. _____/ 6 points
2. _____/ 10 points
3. _____/ 12 points
4. _____/ 18 points
5. _____/ 6 points
6. _____/ 4 points
7. _____/ 6 points
8. _____/ 14 points
9. _____/ 24 points

10. _____/ 2 points (EXTRA CREDIT)

TOTAL: _____/100 points

1. **α-D-mannose is a sweet-tasting sugar. β-D-mannose, on the other hand, tastes bitter. A pure solution of α-D-mannose loses its sweet taste with time as it is converted into the β-anomer.**

Draw the α and β anomers of D-mannose and EXPLAIN with words and/or pictures how the β-anomer is formed from the α-anomer. (6 points)



The β-anomer is formed from the α-anomer by going through the straight chain form, a process called mutarotation.

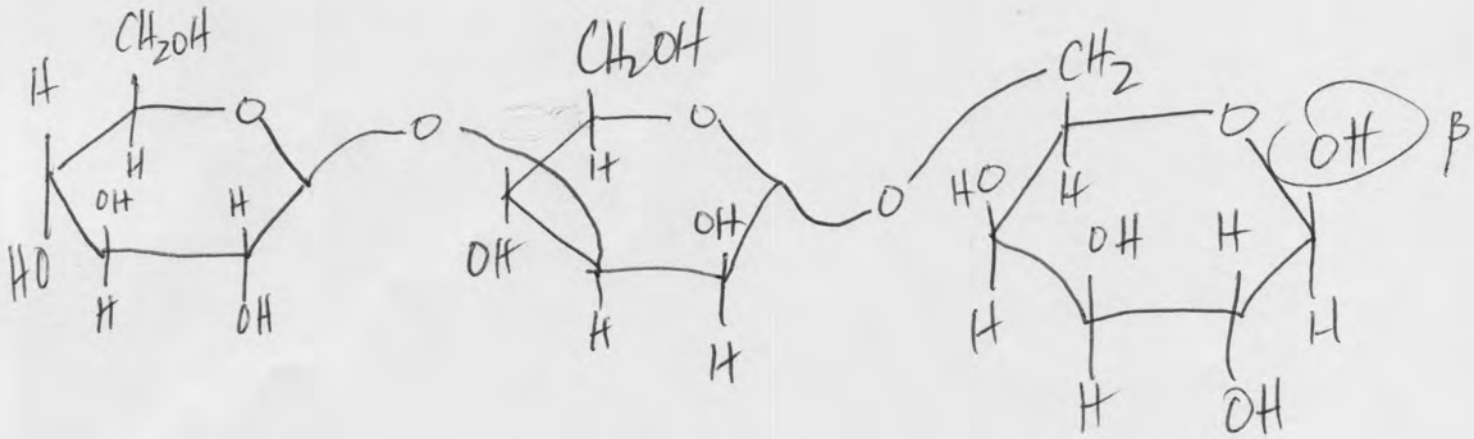
2. **Draw a Haworth projection for the trisaccharide *pumpkinose*, given the following information: (10 points)**

A. It is a trimer composed of D-glucose (1st position) and D-mannose (2nd position) and D-galactose (3rd position)

B. The linkage is between glucose and mannose is β(1 → 3).

C. The linkage between mannose and galactose is α(1 → 6).

D. The anomeric carbon NOT involved in any of the linkages is in the β configuration.



3. Consider the Michaelis-Menten plot shown below: (12 points)

A. Label the 2 types of inhibitor shown by putting the type of inhibitor in the box below the line. (A is the top box and middle line and B is the bottom box and lowest line)

B. What effect (increase, decrease, stay the same) does the inhibitor depicted below have on V_{max}.

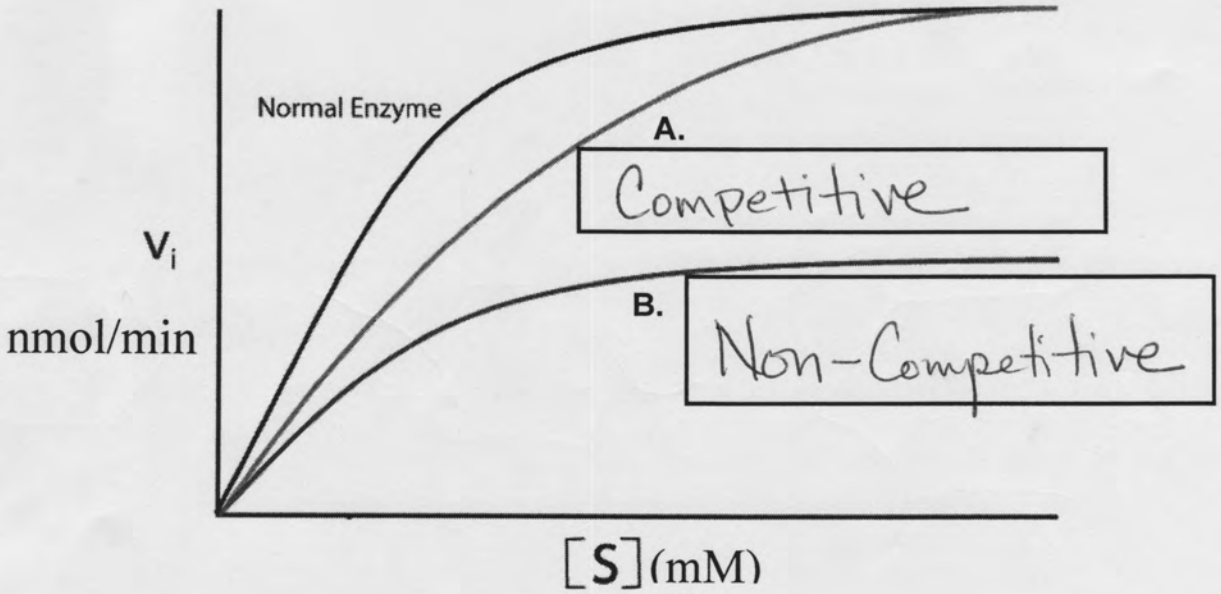
Inhibitor A: Stays the Same

Inhibitor B: Decreases

C. What effect (increase, decrease, stay the same) does the inhibitor depicted below have on K_m.

Inhibitor A: Increases

Inhibitor B: Stays the Same



4. Protein Structure: (18 points)

A. What is meant by the "primary structure" of a protein?

The linear sequence of amino acids

B. Which level(s) of protein structure depend <u>only</u> upon hydrogen bonding between atoms of the peptide backbone?

Secondary Structure (2°)

C. What level of structure includes α-helices and ß-sheets?

Secondary Structure (2°)

D. How is the structure of an α-helix maintained? (Be SPECIFIC about interactions!)

Hydrogen bonding between N-H (amide) & C=O (carbonyl) groups of the backbone.

E. Which levels of protein structure are found in all proteins?

Primary (1°), Secondary (2°), Tertiary (3°)

F. TRUE or FALSE – All of the information necessary for the proper folding a protein is found in the amino acid sequence of the protein.

TRUE

5. (6 points)

A. What two carbohydrate monomers make up **lactose**?

Galactose & Glucose

B. What **specific** linkage joins these monomers?

β(1→4) glycosidic bond

C. Why is lactose digestible to most humans?

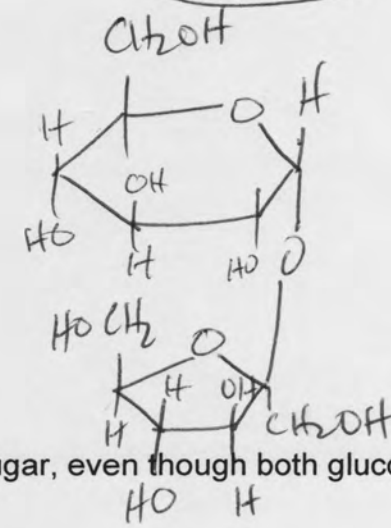
We have the enzyme necessary to break the linkage between the monomers.

6. **Which of the following amino acids would be most likely to be found buried in the interior of a typical protein, and which would be more likely to be found on the protein's surface? Circle the appropriate answer in each case. (4 points)**

Amino acid	Probable location	
Phe	inside	outside
Glu	inside	outside
Leu	inside	outside
Lys	inside	outside

7. **(6 points)**

A. Draw the structure of sucrose.



Glucose $\alpha,\beta(1\rightarrow 2)$ fructose

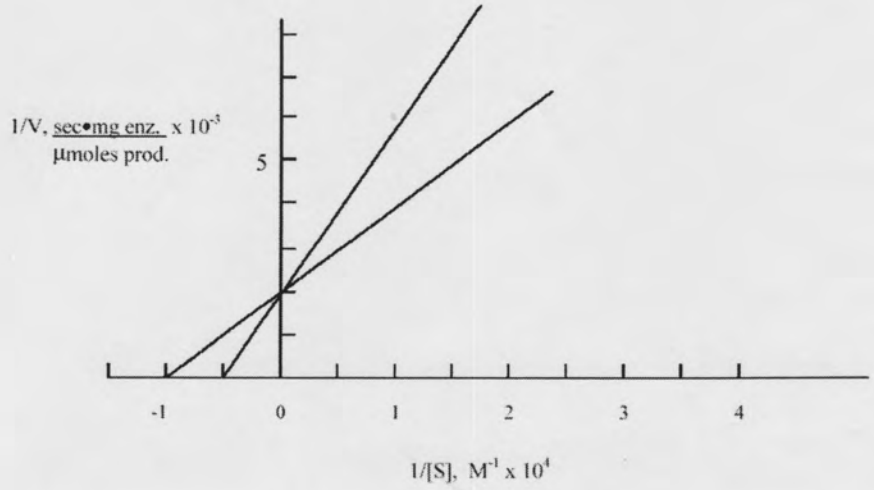
B. Define a "reducing sugar."
Explain why sucrose is not a reducing sugar, even though both glucose and fructose are reducing sugars.) oops!

Both anomeric carbons are involved in the linkage. Need a free anomeric carbon to be a reducing sugar.

C. Why are reducing sugars capable of being metabolized (oxidized) while non-reducing sugars are not?

Because they are capable of opening to the straight chain form, which is the only form that can be metabolized.

8. **A compound has been developed by drug companies that inhibits the enzyme HIV protease, which is necessary for the proper maturation of the virus. The kinetics of the enzyme with and without the protease inhibitor saquinavir are shown in the plot below. (14 points)**



A. HIV protease is known to obey Michaelis-Menten kinetics under the conditions where K_m = 1 mM, V_o = 167 mmol product/sec/mg enzyme, and the substrate concentration is 0.5 mM. Calculate the V_{max} of HIV protease.

$V_o = \frac{V_{max}[S]}{K_m + [S]}$ $167 = \frac{V_{max}[0.5mM]}{0.5 + 1} = \frac{(0.5)(V_{max})}{1.5}$

$167 = \frac{(0.5)(V_{max})}{1.5}$ $250.5 = (0.5)(V_{max})$

$V_{max} = 501$ mmol prod/s/mg enzyme

B. What effects (increase, decrease, stay the same) do **saquinavir** have on:

1. K_m Increases

2. V_{max} Stays the same

3. What type of inhibitor is saquinavir?

Competitive Inhibitor

9. Multiple Choice (2 points each) (24 points)

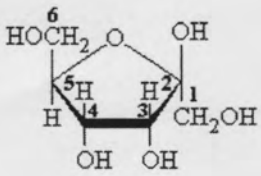
1. Amylose is different from amyolopectin because it is

A. Composed of glucose residues
B. It has more glucose residues
C. It is highly branched
D. It is unbranched
E. It contains no three dimensional structure

D is the correct answer

2. Below is the structure for a cyclic D-monosaccharide. Which is the anomeric carbon atom?

A. 1
B. 2
C. 3
D. 4
E. 5



3. An enzyme shows Michaelis Menten Kinetics. What would be the effect of an uncompetitive inhibitor when analyzed by a Lineweaver-Burk (double reciprocal) plot?

A. V_{max} would decrease, the K_m would not change
B. V_{max} would not change, the K_m would decrease
C. V_{max} would decrease, the K_m would decrease
D. V_{max} would not change, the K_m would not change
E. V_{max} would decrease, the K_m would increase

4. Which is true about the side chains of residues in an α-helix?

A. They point toward the center of the helix.
B. They extend above or below the pleats.
C. They point outward and are perpendicular to the helix axis.
D. They do not hydrogen bond with each other.
E. They have no effect on the stability of the helix.

5. **How does an enzyme's K_m compare to its affinity for substrate?**

A. The greater the K_m, the higher the affinity.

B. The lower the K_m, the higher the affinity.

C. The relationship depends on whether an inhibitor is present or not.

D. The relationship depends on the enzyme's V_{max}.

E. The two have nothing to do with one another.

6. **In the presence of alcohol dehydrogenase, the rate of reduction of acetaldehyde to ethanol increases as you increase the concentration of acetaldehyde. Eventually the rate of the reaction reaches a maximum, where further increases in the concentration of acetaldehyde have no effect. Why?**

A. all of the alcohol dehydrogenase molecules are bound to acetaldehyde molecules

B. at high concentrations of acetaldehyde, the activation energy of the reaction decreases

C. the enzyme is no longer specific for acetaldehyde

D. at high concentrations of acetaldehyde, the $\Delta G^{0'}$ of the reaction decreases

E. the enzyme is denatured

7. **Which statement about enzyme catalyzed reactions is NOT true?**

A. enzymes form complexes with their substrates.

B. enzymes lower the activation energy for chemical reactions.

C. enzymes change the thermodynamics of chemical reactions.

D. many enzymes change shape slightly when substrate binds.

E. reactions occur at the "active site" of enzymes, where a precise 3D orientation of amino acids is an important feature of catalysis.

8. **In the induced fit/transition state analog model of substrate binding to enzymes,**

A. the substrate changes its conformation to fit in the active site

B. the active site changes its conformation to fit the substrate

C. there is a conformational change in the enzyme and the substrate when the substrate binds

D. there is aggregation of several enzyme molecules when the substrate binds

E. multiple substrates fit into the active site at the same time

9. **In glycoproteins, the carbohydrate moiety is always attached through the amino acids:**

A. trp, asn, or cys

B. asn, ser or thr

C. gly, ala or asp

D. asn or glu

E. glu or arg

10. **Which is the Haworth projection of β-D-tagatose?**

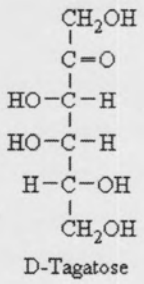
A. I.

B. II.

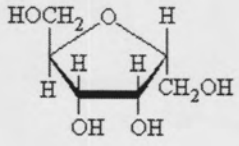
C. III.

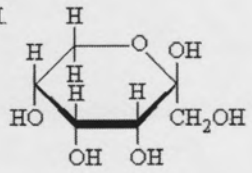
D. IV.

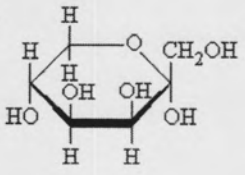
E. none of the above

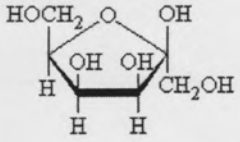


D-Tagatose

I.


II.


III.


IV.


11. The pancreas is protected from digestion by trypsin, a proteolytic enzyme that it produces, because

A. the enzyme works only on denatured proteins.

B. the enzyme is specific for plant proteins.

C. the enzyme works only at the surface of membranes.

D. the enzyme is not activated until it is proteolytically modified.

E. proteins of the pancreas lack bonds susceptible to cleavage by this enzyme.

12. The V_{max} for the substrate to the right in the <u>absence</u> of inhibitor is:

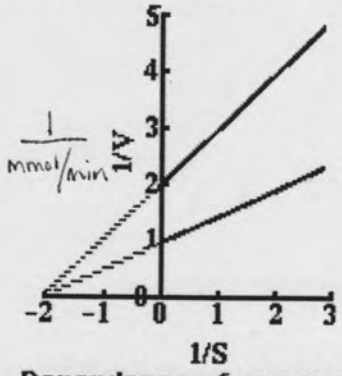
A. 0.5 mmol/min

B. 1 mmol/min

C. 2 mmol/min

D. 2 mM

E. 0.5 mM



Dependence of enzyme rate v (μmol/min) as a function of substrate concentration S (mM). Also shown is the dependence of the rate in the presence of an inhibitor, present at a concentration of 2 mM.

EXTRA CREDIT: (2 points)

1. Spell your professor's last name correctly. (1 point)

HRYCYNA

2. Translate the following amino acid sequence into one letter code to reveal a sentence. Write out the sentence <u>with spaces</u> between the words! (1 points)

Trp Glu Leu Ile Lys Glu Asp Arg His Arg Tyr Cys Tyr Asn Ala Ser Asp Ala Trp Gly Ser.

WE LIKE DR HRYCYNAS DAWGS