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Chem 3511
Final Exam,

The exam starts on the next page. It has 20 questions, worth a total of 200 points. Please write legibly and don't assume that long answers are required if there is a lot of space left for your response. No calculators are allowed.

Some useful tables

		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G

Amino Acid pKa and pI Values

Amino Acid	pK _{aC}	pK _{aN}	pK _{aR}	pI
Glycine	2.4	9.8		6.10
Alanine	2.4	9.9		6.15
Valine	2.3	9.7		6.00
Leucine	2.3	9.7		6.00
Isoleucine	2.3	9.8		6.05
Proline	2.0	10.6		6.30
Serine	2.2	9.2		5.70
Threonine	2.1	9.1		5.60
Cysteine	1.9	10.7	8.4	5.15
Methionine	2.1	9.3		5.70
Asparagine	2.1	8.7		5.40
Glutamine	2.2	9.1		5.65
Phenylalanine	2.2	9.3		5.75
Tyrosine	2.2	9.2	10.5	5.70
Tryptophan	2.5	9.4		5.95
Lysine	2.2	9.1	10.5	9.80
Arginine	1.8	9.0	12.5	10.75
Histidine	1.8	9.3	6.0	7.65
Aspartate	2.0	9.9	3.9	2.95
Glutamate	2.1	9.5	4.1	3.10

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- 1. (40pts) Matching:** Complete each sentence (1-20) with one of the words (A-BB) below. The letters can be reused. Not all the letters are needed. 2 point per correct answer.

A. Rate determining	K. Purine	S. Decrease
B. Positive	L. Peptide bond	T. H-TS
C. 3 ^{ry} structure	M. Phosphodiester	U. Mitochondria
D. Pyrimidine	bond	V. Increases
E. Deprotonated	N. C3'-endo	W. Protonated
F. Cytosol	O. Negative	X. H ₂ PO ₄ ⁻
G. C2'-endo	P. High	Y. Disordered
H. Sterol	electronegativity	Z. Three
I. 2 ^{ry} structure	Q. HPO ₄ ²⁻	AA. Hydrogen bond
J. Two	R. Zero	BB. H+TS

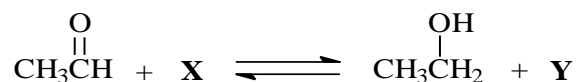
1. Spontaneous processes are characterized by a change in Gibbs free energy that is _____.
2. Gibbs free energy is defined as $G =$ _____.
3. Glycolysis takes place in the _____.
4. The polarity of the O-H bond is caused by the _____ of oxygen relative to that of hydrogen.
5. For the _____ represented by D-H---A, the donor D is weakly acidic and the acceptor A is weakly basic.
6. Octane molecules dispersed in water tend to aggregate because that allows water molecules to be more _____.
7. The maximal number of hydrogen bonds a single molecule of methanol can form with surrounding water is _____.
8. The ionic form of phosphoric acid (pK values of 2.14, 6.86, and 12.38) at pH=9.3 is _____.
9. Members of the _____ family have four fused, nonplanar rings and a C3-OH group.

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10. Cytosine, uracil, and thymine are derivatives of _____.
11. In B-DNA, the 2-deoxyribose group assumes the _____ conformation.
12. The net charge of the zwitterion form of Gly is _____.
13. At a pH above its pK_a , the phenol group of tyrosine is _____.
14. In the tripeptide Lys—Pro—Ile, there are _____ charged groups at pH 7.
15. At a pH below its pK_a , the ϵ -amino group of lysine is _____.
16. At a pH below its pK_a , the β -carboxylate group of Asp is _____.
17. The overall arrangement of the regular structural elements such as the α helix and the β sheet in the protein are considered the protein's _____.
18. A rigid, planar structure between at least two amino acids consisting of about 40% double bond character is characteristic of a _____.
19. The absence of 2,3-BPG causes hemoglobin's affinity for oxygen to _____.
20. On a transition state diagram for a multistep reaction, the step with the greatest ΔG is the _____.

(65 pts) Multiple Choice (5 points per question)

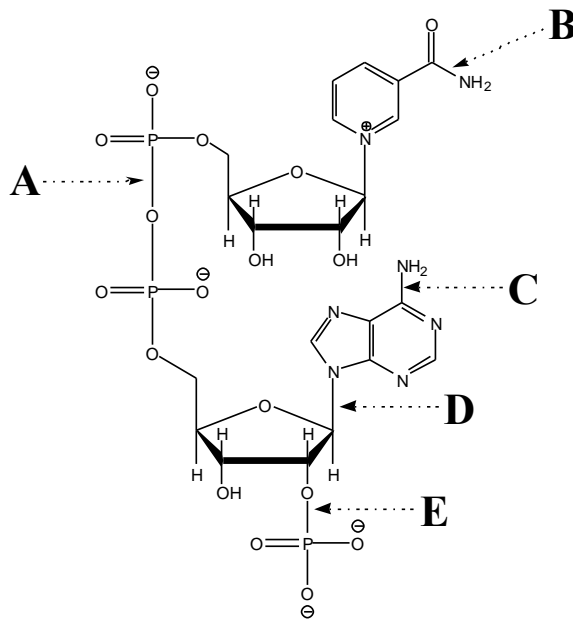
2. The reaction below is catalyzed by yeast alcohol dehydrogenase. Which of the following corresponds to X and Y in this reaction?



- | | |
|---|---------------------------------------|
| A) $\text{X} = \text{NADH}^+$ | $\text{Y} = \text{NAD} + \text{H}^+$ |
| B) $\text{X} = \text{NAD}^+$ | $\text{Y} = \text{NADH} + \text{H}^+$ |
| C) $\text{X} = \text{NADH} + \text{H}^+$ | $\text{Y} = \text{NAD}^+$ |
| D) $\text{X} = \text{NAD} + \text{H}^+$ | $\text{Y} = \text{NADH}^+$ |
| E) $\text{X} = \text{NADPH} + \text{H}^+$ | $\text{Y} = \text{NADP}^+$ |

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3. Which mechanism is the method by which antenna complex chlorophylls funneled energy toward the reaction centers?
- A) fluorescence
 - B) internal conversion
 - C) resonance energy transfer (exciton transfer)
 - D) electron transfer
 - E) none of the above
4. For the figure below. The arrows **A, B, C, D, E** (in this order) point to which bonds



- A) Anhydride, amino, phosphate ester, glycosidic , amide
- B) Anhydride, amide, amino, glycosidic, phosphate ester
- C) Phosphate ester, anhydride, amide, glycosidic, amino
- D) Phosphate ester, glycosidic, anhydride, amino, amide
- E) Glycosidic, phosphate ester, anhydride, amide amino

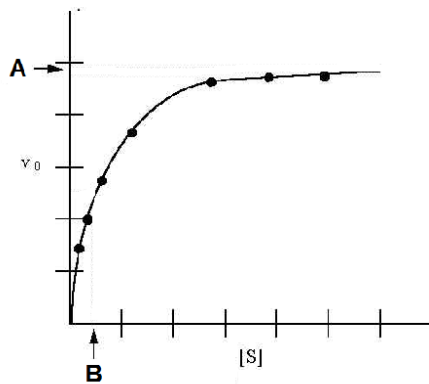
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5. Which features allow the KcsA channel to selectively transport K^+ ?

- I. The entrance of the channel contains hydrophobic residues which forces the removal of waters of hydration.
- II. It is attracted to the entrance of the channel via electrostatic interactions.
- III. The “selectivity filter” involves a narrowing of the channel, allowing only dehydrated K^+ access.
- IV. As K^+ is transported through the channel it interacts with $-C=O$ groups from the protein.

- A) I, II, III, IV
- B) II, III, IV
- C) II, III
- D) III, IV
- E) I, III

6. Based on the figures below, which of the following expressions is correct for A, B and D?



- A) $A = k_{cat}$, $B = k_{cat} / K_M$,
- B) $A = k_{cat} / K_M$, $B = k_{cat}$
- C) $A = V_{max} / k_{cat}$, $B = K_M$,
- D) $A = V_{max}$, $B = K_M$,
- E) $A = K_M$, $B = V_{max}$,

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7. Cells control or regulate the flux through metabolic pathways by means of

- I. allosteric control of enzymes.
- II. covalent modification of enzymes.
- III. genetic control of the concentrations of enzymes.
- IV. genetic expression of allosteric effectors.

- A) I, II, III, IV
- B) II, III
- C) I, II, IV
- D) I, II, III
- E) I, IV

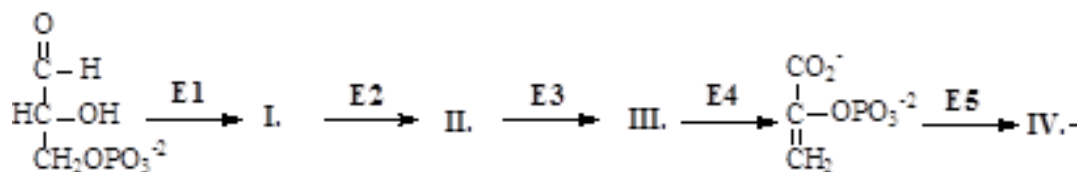
8. Use the table below to rank the redox centers in order to produce a favorable electron flow.

Redox Center	$\epsilon^{0'}$
D	- 0.002
F	- 0.198
Q	- 0.225
C	- 0.053
Z	+ 0.002

- A) D, Q, F, C, Z
- B) Q, F, C, D, Z
- C) Z, D, C, F, Q
- D) Z, F, C, D, Q
- E) Z, Q, C, Q, D

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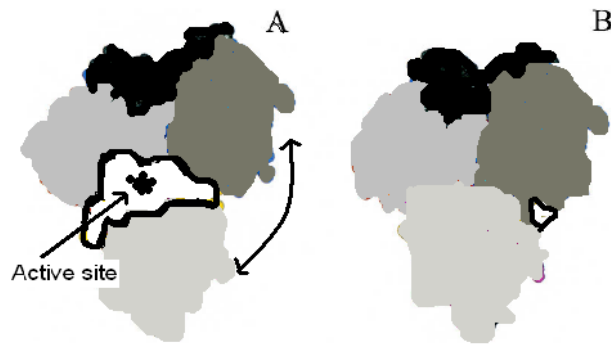
9. Consider the following portion of the glycolytic sequence catalyzed by the enzymes above the arrows. Which enzymatic steps will produce ATP?



- A) E1, E4
B) E2, E5
C) E2 only
D) E3, E4
E) E1 only
10. I propose to design a new drug which will act as an inhibitor for an enzyme. If I have used all current information about the mechanism of this enzyme to design this inhibitor and I carefully engineer it with similar chemical properties of the transition state, what type of inhibitor am I attempting to engineer and how will I know if I have succeeded?
- A) A competitive inhibitor, collect kinetic data both in the presence and absence of inhibitor and watch for a change in V_{\max} .
B) A competitive inhibitor, collect kinetic data both in the presence and absence of inhibitor and watch for a change in K_M .
C) A uncompetitive inhibitor, collect kinetic data both in the presence and absence of inhibitor and watch for a change in K_M .
D) A uncompetitive inhibitor, collect kinetic data both in the presence and absence of inhibitor and watch for a change in V_{\max} .
E) None of the above.

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11. The enzyme pictured below is shown in two configurations, A (open) and B (closed). Upon binding substrate in the active site, the enzyme converts the structure shown in B. Which of the following is true based on the given information?



- A) The enzyme requires a high concentration of substrate to function
 - B) This example exemplifies the “lock-and-key” model.
 - C) This enzyme must require ATP.
 - D) This example exemplifies the “induced fit” model.
 - E) None of these are true.
12. Which of the following is the best explanation for the hydrophobic effect?
- A) It is caused by an affinity of hydrophobic groups for each other.
 - B) It is caused by the affinity of water for hydrophobic groups.
 - C) It is an entropic effect, caused by the desire of water molecules to increase their entropy by forming highly ordered structures around the hydrophobic groups.
 - D) It is an entropic effect, caused by the desire of water molecules to increase their entropy by excluding hydrophobic groups, which they must otherwise surround with highly ordered structures.
 - E) It is an entropic effect caused by the desire of hydrophobic groups to increase their entropy by associating with other hydrophobic groups.

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13. Radioactively labeled, single-stranded oligonucleotides (DNA) are often used in *in situ* hybridization. Which of the probes listed below would work best, when probing for a RNA molecule containing the sequence 5'-AGCUAACGGG-3'?

- A) 5'-AGCTAACGGG-3'
- B) 5'-GGGCAATCGA-3'
- C) 5'-CCCGTTAGCT-3'
- D) 5'-TCGATTGCCC-3'
- E) all of the above

14. Cold blooded animals modulate the fatty acid composition of their membranes as a function of temperature in order to

- A) adjust the membrane thickness and increase thermal insulation.
- B) maximize available fatty acids for metabolic use.
- C) ensure consistent membrane fluidity.
- D) compensate for decreasing cholesterol solubility.
- E) all of the above

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15. (19 pts) RNA

A) Using a Scheme explain why RNA is less stable than DNA (10 pts)

B) Explain the different functions of mRNA, tRNA and rRNA (9 pts)

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16. (22 pts) Proteins

- A) Draw a β -sheet, with two strands and 5 amino acids each strand. The sheet must be antiparallel. Draw the correct stereochemistry at the $C\alpha$'s. The side chains should be all R. (10pts)

17. (12 pts) Consider the following peptide: Cys-His-Tyr-Met-Glu-Trp

Using the correct stereochemistry try at the $C\alpha$ position, and the predominant ionization states of all the sidechains, draw the peptide at pH=5

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18. (16pts) Carbohydrates and Metabolism

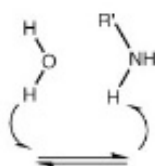
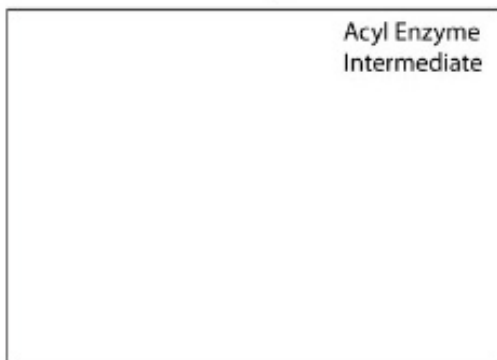
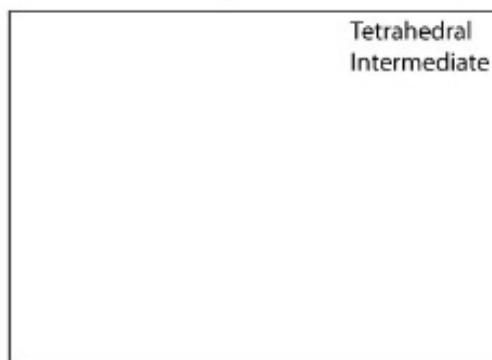
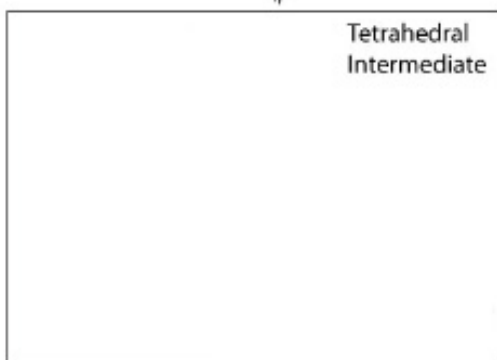
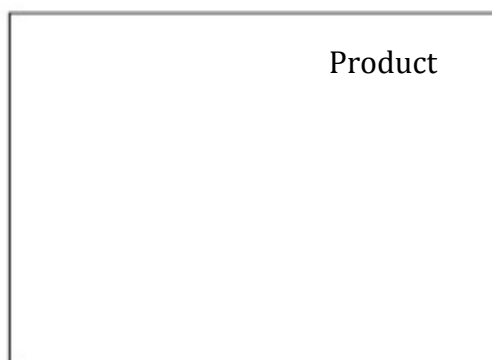
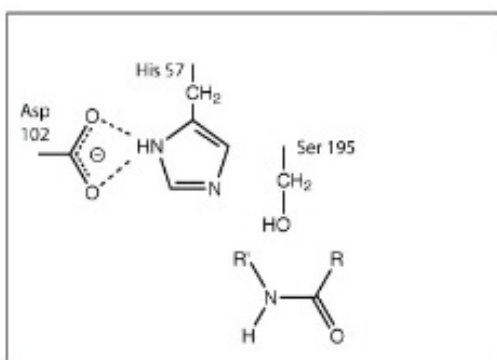
- A) **(9pts)** Draw the reaction for conversion between α and β anomers of D-glucose, include the linear intermediate (**3 pts** per structure).

- B) **(7pts)** You go to a restaurant and your friend orders “Mexican Coke” rather than regular Coke. Your friend explains you that Mexican Coke is made with cane sugar (sucrose, a disaccharide of glucose and fructose) rather than high fructose corn syrup and that is why it is better.

Explain your friend how the carbohydrates in “Mexican Coke” and regular coke would be metabolized differently or the same

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- 19. (20 pts)** In the boxes below, sketch the mechanism of a serine protease. Indicated the electron flow using curved arrows. It is not necessary to give amino acid labes (as in first panel)



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20. (18pts) DNA

A) **(10pts)** Draw the G-C Watson-Crick base pair (**5 pts per base**)

B) **(8pts)** Shown below are the three forms that DNA can adopt.

- i. Circle and label the DNA form most likely to be found in nature (**2 points**)
- ii. List 3 major differences between A-form and B-form DNA (**6 points**)

