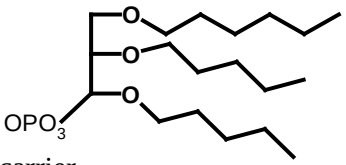
There are 8 pages on this exam. Please write your name on each page.
Total number of points: 106 [Budget 1 min/2 points]

Section A: Multiple Choice (2 Pts each, 20 Points)

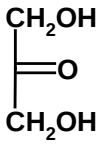
1. The compound shown to the right is a:



a) fatty acid.
b) triglyceride.
c) hydrophobic electron carrier.
d) none of the above.

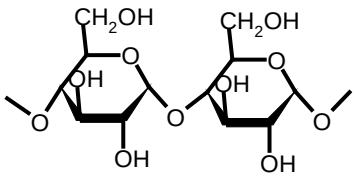
2. Phospholipid bilayers are organized such that the ___ face the solvent and the ___ are directed toward the interior of the bilayer.
a) hydrophobic tails; hydrophilic heads.
b) carboxylic acid groups; hydrocarbon chains.
c) hydrocarbon chains; phosphate-ester head groups.
d) phosphate-ester head groups; hydrophobic tails.

3. The structure shown to the right is:



a) an aldose.
b) a ketose.
c) glycerol.
d) none of the above.

4. The disaccharide linkage shown in the structure is a ____ linkage and is found in _____:



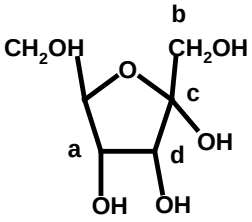
a) α(1-4), cellulose.
b) β(1-4), cellulose.
c) β(1-4), bacterial cell walls.
d) α(1-4), glycogen.

5. Which degradative metabolic pathway begins in the cytosol but finishes in the mitochondrial matrix.
a) glycolysis.
b) gluconeogenesis.
c) TCA (Krebs) cycle.
d) β-oxidation of fatty acids.

6. The compound that serves as a common intermediate in both the TCA cycle and β-oxidation is:
a) acetaldehyde.
b) lactic acid.
c) acetic acid.
d) acetyl-CoA.

7. Which of the following functions as a second messenger in the hormonal signal transduction pathway?
a) ATP.
b) cAMP.
c) caffeine.
d) both b and c.

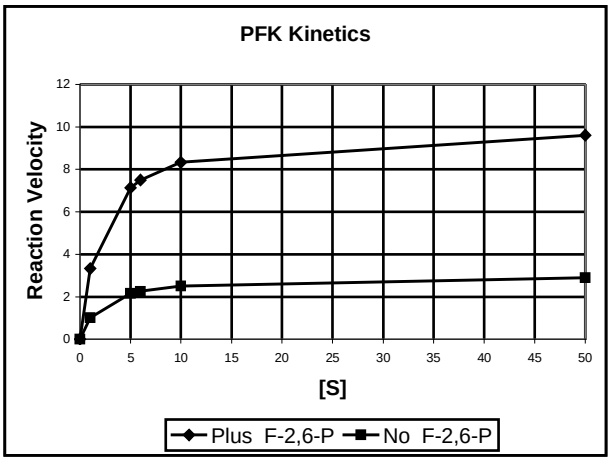
8. Which carbon is the anomeric carbon in this sugar?



a)
b)
c)
d)

9. A 1000 fold difference in fructose concentration across a membrane represents the storage of how much energy (T=300K)?
a) None, since fructose is not charged.
b) Sufficient to synthesize ATP.
c) Cannot be calculated since $\Delta\Psi$ is unknown.
d) Sufficient to synthesize glucose-6-phosphate.

10. The reaction velocity of PFK (Phosphofructokinase) with and without fructose-2,6-phosphate (F-2,6-P) is shown below. On this basis of this data:



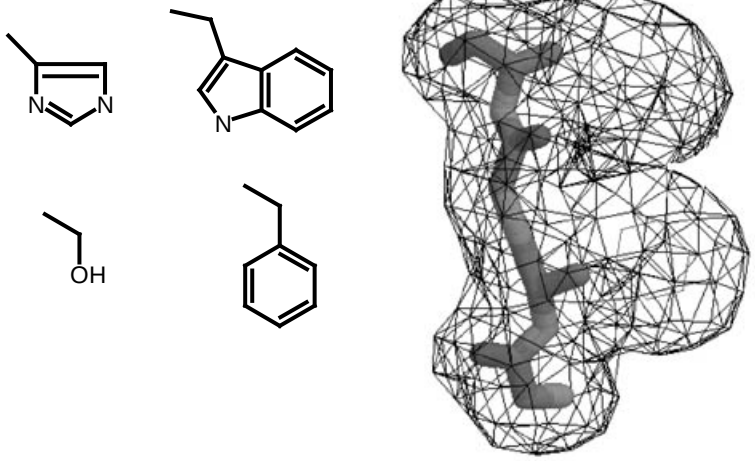
a) F-2,6-P has no effect on PFK activity.
b) F-2,6-P is a competitive inhibitor of PFK
c) F-2,6-P is an allosteric activator of PFK
d) F-2,6-P is an allosteric inhibitor of PFK

GRADE:

A: _____/20
B1: _____/10
B2: _____/12
B3: _____/ 4
B4: _____/ 4
B5: _____/ 6
B6: _____/12
B7: _____/ 5
B8: _____/ 5
B9: _____/14
B10: _____/14
Total:_____/106

B1. (10 pts) Please do **one** of the following two questions.

Choice A: An electron density map of a four residue segment of a protein is shown to the right. The mainchain atoms as well as the C_β atoms have already been placed in this map. Which of the following peptide sequences best accounts for this electron density (6 pts). *Briefly justify your answer* (4 pt).



The side chain atoms of Serine (Ser), Histidine (His), Phenylalanine (Phe), and Tryptophan (Trp) are shown adjacent to the electron density, *in random order.*

i) Gly-Ser-Gly-Ser
ii) Gly-His-Gly-Ser
iii) Gly-Phe-Gly-Phe
iv) Gly-Trp-Gly-Trp

Choice B: The molecular weight and charge at pH 7.0 of three proteins is listed in the table below.

	Molecular Weight	**Charge at pH 7.0**
Lysozyme	15 kDa	0
Hexose kinase	60 kDa	+2
Hemoglobin	60 kDa	+2

i) How might you separate lysozyme from a mixture of lysozyme and hexose kinase? Briefly explain the separation principal. (6 pts)

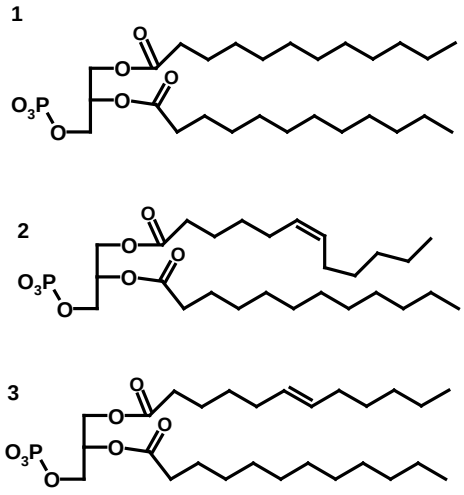
ii) A graduate student in my lab is able to separate hexose kinase from a mixture of hexose kinase and hemoglobin. How did she accomplish this feat? (4 pts)

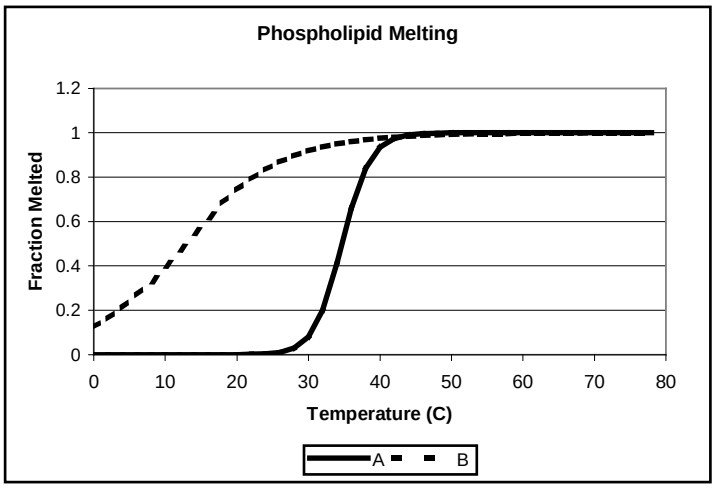
B2. (12 pts) Please answer **one** of the following **two** questions.

Choice A: Briefly describe the principal thermodynamic force that drives the self assembly of lipid bilayers from phospholipids. Then discuss the main differences in the structure of integral membrane proteins versus soluble proteins.

OR

Choice B: The following graph shows the melting curve of two different phospholipid bilayers. The structures of three phospholipids are shown adjacent to the melting curve. Which phospholipid corresponds to which melting curve? Briefly justify your answer with reference to *both* T_M as well as the shape of the melting curve.





B3: (4 pts) Please answer **one** of the following two questions.

Choice A: What is the most significant difference between starch and glycogen? Why is this difference beneficial to animals?

OR

Choice B: Briefly describe the structure of bacterial cell walls and discuss how the enzyme lysozyme is able to digest bacterial cell walls but not cellulose.

B4:(4 pts) Please do **one** of the following two questions.

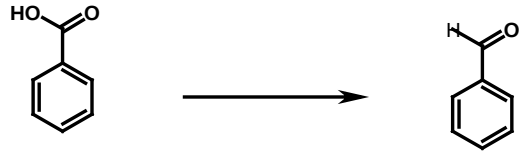
Choice A: State the first metabolic pathway that would be used to metabolize the following foods.

Food	Pathway
Protein from tofu	
Triglycerides from margarine	

Choice B: Briefly distinguish feedback inhibition from product inhibition.

B5: (4 pts) Select **one** of the following **four** enzyme catalyzed reactions and indicate any additional substrates and/or products that would be required in the reaction. Write the general or generic name of the enzyme that would catalyze the reactions that you have selected.

Enzyme Name



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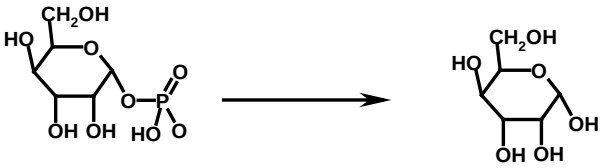

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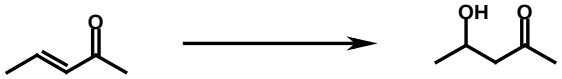

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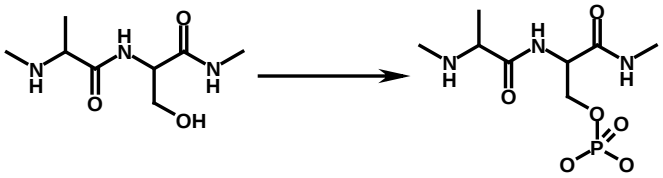

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B6: (12 pts) *Briefly* answer **one** of the following **two** choices. A labeled diagram is an acceptable answer.

Choice A: Discuss how the energy associated with the oxidation of succinate to fumarate (producing $FADH_2$) is converted into a proton gradient across the inner mitochondrial membrane.

OR

Choice B: Discuss the mechanism by which the proton gradient across the inner mitochondrial membrane is used to generate ATP from ADP and P_i

B7: (5 pts) Answer **one** of the following two questions:

Choice A: The Gibbs free energy associated with the transport of molecules across the membrane is:

$$\Delta G = RT \ln \frac{[X]_{IN}}{[X]_{OUT}} + ZF\Delta\Psi$$

i) What is the origin of the second term ($ZF\Delta\Psi$)?(2 pt) Why is it important in ATP generation?(1 pt)

ii) If $\Delta G=0$, in what direction will [X] flow? Briefly justify your answer (2 pts).

Choice B: Consider the following hypothetical metabolic pathway: $A \xrightarrow{E_1} B \xrightarrow{E_2} C$

The conversion of A to B has a large positive ΔG^o, yet there is net conversion of A to B during the normal function of this pathway. Explain how this occurs.

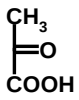
B8: (5 pts) Please answer **one** of the following two questions.

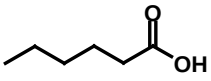
Choice A: Why is it advantageous for an athlete to consume large amounts of carbohydrates several days before an event?

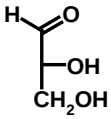
OR

Choice B: Why is it less important for a marathon runner to have a high carbohydrate diet?

B9: (12 pts) You need answer only **one** of the following two questions. The following molecules may be useful.







Choice A: Discuss the major energy generating step(s) in *either* glycolysis *or* the TCA cycle. In both cases give the substrates and products of the reaction and indicate how the energy associated with the reaction is stored for subsequent conversion to ATP.

OR

Choice B: Sketch the changes in the carbon skeleton that occur during the complete oxidation of a six (6) carbon fatty acid. Give the net yield of $FADH_2$ and NADH by this process.

B10: (14 pts) You need only do **one** of the following three questions:

Choice A: Discuss regulation of *either* glycolysis *or* the TCA cycle by "energy sensing". In your answer you should give an example of a regulatory step and indicate how it is regulated. Your answer should also indicate why this regulation is of benefit to the organism.

OR

Choice B: Discuss how protein phosphorylation regulates glycogen metabolism in the liver. Your answer should indicate how this regulation is of benefit to the organism.

OR

Choice C. Discuss how F2,6-P regulates glycolysis and gluconeogenesis in the liver. Your answer should indicate how this regulation is of benefit to the organism.